P&C Technologies Co., Ltd.

User’s Guide

Over Voltage & Under Voltage Relay: PAC-E500

Table of Contents

1 Overview 5
1.1 Features 5
1.2 Functional Single Line Diagram 6

2 Technical Data 7
2.1 General Specifications 7
2.1.1 Current Input 7
2.1.2 Rated Control Source 7
2.1.3 Rated Frequency 7
2.1.4 Contact Output 7
2.1.5 Contact Input 7
2.1.6 Case 7
2.2 Protection Elements 8
2.2.1 Over Voltage Protection 8
2.2.2 Under Voltage Protection 8
2.2.3 Ground Over Voltage Protection 8
2.2.4 Negative Phase Sequence Over Voltage Protection 8
2.2.5 Under Frequency Protection 9
2.3 Environmental Tests 9
2.3.1 Insulation Tests 9
2.3.2 Electromagnetic Compatibility Tests 10
2.3.3 Mechanical Tests 11
2.3.4 Environmental Conditions 11

3 Functional Description 12
3.1 Protection Functions 12
3.1.1 Over Voltage 12
3.1.2 Under Voltage 13
3.1.3 Ground Over Voltage 14
3.1.4 Negative Phase Sequence Over Voltage 16
3.1.5 Under Frequency 17
3.2 Additional Functions 18
3.2.1 Control 18
3.2.2 Measurement & Metering 19
3.2.3 Programmable Logic 19
3.2.4 Self Diagnosis 21
3.2.5 Communication 21
3.2.6 Setting & Configuration Software 22

4 Operational Description 23
4.1 Front Panel Construction 23
4.1.1 Front Panel Operation 23
4.1.2 LEDs 24
4.1.3 Keypad 24
4.2 Key Manipulation & Menu 25
4.2.1 Basic Principle of Key Manipulation 25
4.2.2 Menu Tree 26
4.3 Initial Display 28
4.4 Menu Tree Display 28
4.4.1 DISPLAY Menu 29
4.4.1.1. DISPLAY/STATUS 29
4.4.1.2. DISPLAY/STATUS/CONTACT INPUT 30
4.4.1.3. DISPLAY/STATUS/CONTACT OUTPUT 30
4.4.1.4. DISPLAY/STATUS/SELF DIAGNOSIS 30
4.4.1.5. DISPLAY/STATUS/PROTECTION 31
4.4.1.6. DISPLAY/MEASURE 32
4.4.1.7. DISPLAY/SYSTEM INFO. 33
4.4.2 SETTING Menu 34
4.4.2.1. SETTING/SYSTEM 34
4.4.2.2. SETTING/SYSTEM/POWER SYSTEM 35
4.4.2.3. SETTING/SYSTEM/CB CONTROL 36
4.4.2.4. SETTING/SYSTEM/ PT FUSE MONITOR 37
4.4.2.5. SETTING/SYSTEM/COM 37
4.4.2.6. SETTING/SYSTEM/DNP3.0 38
4.4.2.7. SETTING/SYSTEM/CONTACT INPUT 39
4.4.2.8. SETTING/SYSTEM/CONTACT OUTPUT 40
4.4.2.9. SETTING/SYSTEM/LED 42
4.4.2.10. SETTING/SYSTEM/PASSWORD 43
4.4.2.11. SETTING/PROTECTION 44
4.4.2.12. SETTING/PROTECTION/OV1 (59_1) 45
4.4.2.13. SETTING/PROTECTION/OV2 (59_2) 46
4.4.2.14. SETTING/PROTECTION/UV1 (27_1) 47
4.4.2.15. SETTING/PROTECTION/UV2 (27_2) 48
4.4.2.16. SETTING/PROTECTION/OVG1 (59G_1) 49
4.4.2.17. SETTING/PROTECTION/OVG2 (59G_2) 50
4.4.2.18. SETTING/PROTECTION/OVG3 (59G_3) 51
4.4.2.19. SETTING/PROTECTION/NSOV (47) 52
4.4.2.20. SETTING/PROTECTION/UF (81) 52
4.4.3 COMMAND Menu 54
4.4.3.1. COMMAND/CONT OUT TEST 54
4.4.3.2. COMMAND/PANEL TEST 55

5 Dimensions and External Connections 56
5.1 Dimensioned Drawings 56
5.2 External Connections 58
5.2.1 Control Source 58
5.2.2 CT Connections 58
5.2.3 PT Connections 59
5.2.4 Input/Output Contacts Connection 61
5.2.5 RS232 Port Connection 61
5.2.6 RS485 Port Connection 62
5.2.7 Wiring Diagram 63

6 Setting & Configuration Software 64
6.1 Setting Software 64
6.1.1 Program Menu 64
6.1.2 Device Selecting 65
6.1.3 Communication Port Setting 65
6.1.4 System Configuration 66
6.1.5 Protection Setting 67
6.1.6 Contact In/Out Setting 68
6.1.7 LED Setting 69
6.1.8 Monitor 70

Appendix A. TC Characteristics Curves 71

Appendix B. Ordering Option 75

1 Overview

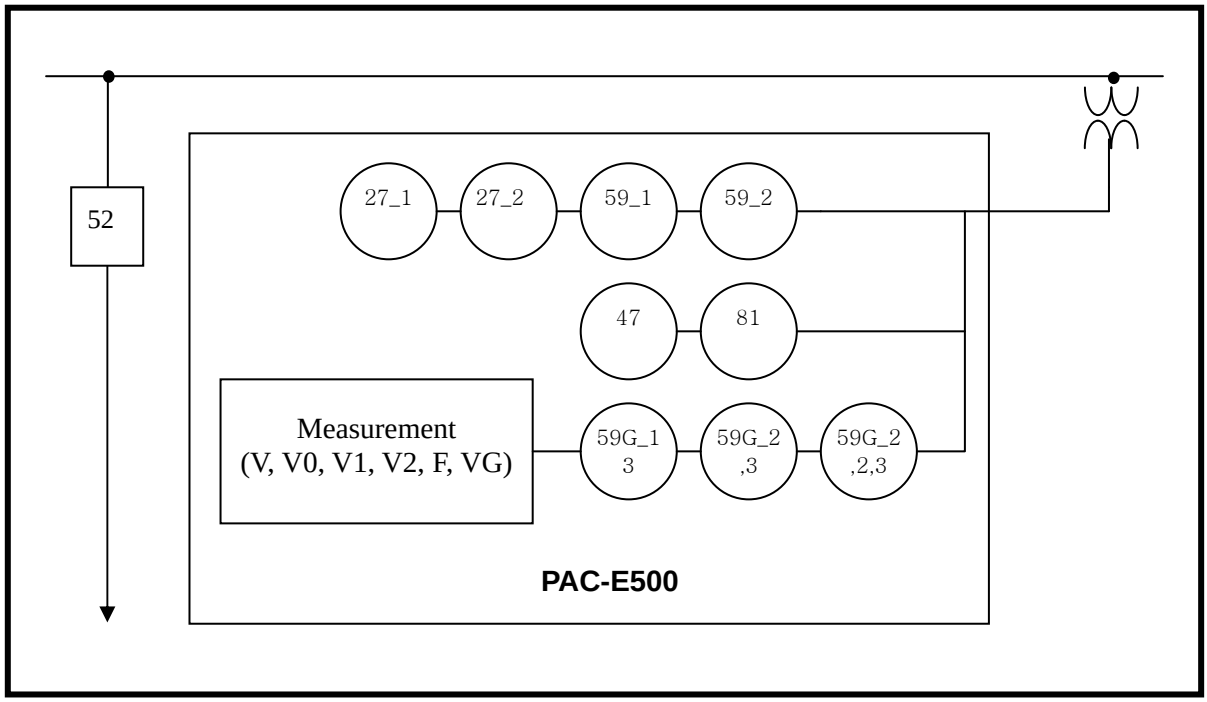
PAC-E500, Over Current & Earth Fault Relay is a microprocessor-based numerical protection relay designed for the management and protection of a distribution feeder. PAC-E500 has the protection elements of Over Voltage (OVR), Under Voltage (UVR), Ground Over Voltage (OVGR), Negative Phase Sequence Over Voltage and Under Frequency. It uses Normal Inverse of TC curves (1 OVR and UVR, 2 OVGR). Also it provides the measurements of Line-to-Line voltage, 3 phase currents and voltages, Sequence Voltage, THD (Total Harmonic Distortion), frequency, and PT fuse fail monitor, and control functions for a circuit breaker.

Programmable Logic is designed for the replacement of external wiring for the sequence logic and it has 48 configurable logic components. The configurations of contact inputs/outputs are very easy with Programmable Logic. Programmable Logic is specially designed software for easy maintenance and operation of PAC-E500.

1.1 FEATURES

- □ Numerical-type Over Voltage (OVR), Ground Over Voltage (OVGR), Under Voltage, Negative Phase Sequence Over Voltage, and Under Frequency Protections
- □ Various TC Curves including 1 OVR and UVR, 2 OVGR.
- □ Digital Indication of Setting and Metering on LCD (2 Lines × 16 Characters)
- □ Self-Diagnosis and Internal Status Monitoring
- □ Operation Blocking of Individual Relay Element by External Contact Inputs during the Relay Maintenance
- □ Configurable System Frequency (50 / 60Hz)
- □ Easy setting of 4 Contact Outputs and 4 Programmable LED to use Logic
  Contact Output: Available Trip and Signaling Contact
- □ Direct Trip/Close Control of 1 CB from Front Panel Locally and SCADA remotely
- □ Useful PC Application (Setting Tool)
  : System Configuration, Protection & Logic Setting, Monitoring & Measurement
- □ Self-Test Function of Contact Output by Manual Trip Emulation
- □ Access Security by Password for Setting Change and CB Control.
- □ Communication Interface
  - RS-232C (Front and Rear), RS485C (SCADA Communication)
  - Protocol: MODBUS, DNP3.0, IEC60870-5-103
- □ Measurement: 3-phase voltages, Sequence Voltages, Thermal, Frequency
- □ EMI/EMC Performance Reinforced.

1.2 FUNCTIONAL SINGLE LINE DIAGRAM



<Figure 1.2. PAC-E500 Functional Single Line Diagram>

Device Number	Function
59_1,2	Over Voltage Protection
27_1,2	Under Voltage Protection
47	Negative Phase Sequence Over Voltage Protection
81	Under Frequency Protection
59G_1,2,3	Ground Over Voltage Protection
52	CB (AC Circuit Breaker)

2 Technical Data

2.1 GENERAL SPECIFICATIONS

2.1.1 Current Input

Rated Current	AC 1A/5A (50/60Hz)
Input range	0.01 ~ 50 * In
Thermal Withstand Capability	3 times of rated value: Continuous 20 times of rated value: 4 sec 40 times of rated value: 2 sec 100 times of rated value: 1 sec
Burden	＜0.5VA / phase

2.1.2 Rated Control Source

Voltage : 110 ~ 220 VAC±20%, 80 ~ 300 VDC, Power Consumption: ＜30 VA
(Option: 24 ~ 48 VDC)

2.1.3 Rated Frequency

50Hz or 60Hz

2.1.4 Contact Output

For Trip: 4points (2A, 2C), Configurable	
Rated Load	10A / 0.3sec / AC 250V / Resistive Load
	30A / 0.3sec / DC 125V / Resistive Load
Switching capacity	1A / 0.1 (PF) / AC 250V
	1A / 25ms (L/R time constant) / DC 125V

2.1.5 Contact Input

4 Points Dry Contact, Configurable	
When no applied voltage	＞1000Ω
When voltage supplied	DC 125V
Recognition time	＜10ms

2.1.6 Case

Construction	Draw-out type
IP Protection Level	IP51
Material	Steel with Hard-Combustion Plastic Cover

2.2 PROTECTION ELEMENTS

2.2.1 Over Voltage Protection

Pickup	5~170V (1V step)
TC Curve	-Inverse -Definite Time
Multiplier	0.01 ~ 10.0 (0.01 step)
DT operate time	0.00 ~ 60.00 sec (0.01 sec step)
Reset	>97 ~ 98 % of pickup value
Operation accuracy	< ± 2 % of set value
Timing accuracy	< ± 35ms (Inst., op. time <700ms) ± 3 % (op. time >700ms)

2.2.2 Under Voltage Protection

Pickup	5~170V (1V step)
TC Curve	-Inverse -Definite Time
Multiplier	0.01 ~ 10.0 (0.01 step)
DT operate time	0.00 ~ 60.00 sec (0.01 sec step)
Reset	>102~103 % of pickup value
Operation accuracy	< ± 2 % of set value
Timing accuracy	< ± 35ms (Inst., op. time <700ms) ± 3 % (op. time >700ms)

2.2.3 Ground Over Voltage Protection

Pickup	5~170V (1V step)
TC Curve	-Inverse Trip, Inverse Alarm -Definite Time
Multiplier	0.01 ~ 10.0 (0.01 step)
DT operate time	0.00 ~ 60.00 sec (0.01 sec step)
Reset	>97 ~ 98 % of pickup value
Operation accuracy	< ± 2 % of set value
Timing accuracy	< ± 35ms (Inst., op. time <700ms) ± 3 % (op. time >700ms)

2.2.4 Negative Phase Sequence Over Voltage Protection

Pickup	5~170V (1V step)
DT operate time	0.00 ~ 60.00 sec (0.01 sec step)
Reset	>97 ~ 98 % of pickup value
Operation accuracy	< ± 2 % of set value
Timing accuracy	< ± 35ms (Inst., op. time <700ms) ± 3 % (op. time >700ms)

2.2.5 Under Frequency Protection

UV Pickup	5 ~ 170 V (1 V step)
OC Pickup	0.10 ~ 20.00 * In (0.01 * In step)
dF/dT Pickup	-10.00 ~ -0.10 Hz (0.01 Hz step)
Freq Pickup	45.00 ~ 65.00 Hz (0.01 Hz step)
DT operate time	0.00 ~ 180.00 sec (0.01 sec step)
Reset	>102`103 % of pickup value
Operation accuracy	< ± 2 % of set value
Timing accuracy	< ± 35ms (Inst., op. time <700ms) ± 3 % (op. time >700ms)

2.3 ENVIRONMENTAL TESTS

2.3.1 Insulation Tests

Insulation resistance	To measure with 500 Vdc insulation resistance tester Overall Electric Circuit – Enclosure : 10MΩ Between Electric Circuits : 5 MΩ Between Contacts : 5 MΩ	IEC60255-5, ANSI/IEEE C37.90.0
Dielectric test voltage	Applied Time: 1 min (50/60 Hz) Overall Electric Circuit – Enclosure : 2kV Between Electric Circuits : 2 kV Between Contacts : 1 kV	IEC60255-5
Impulse test voltage	Applied Waveform: 1.2×50μs Applied Time: Each Positive/Negative 3 times Overall Electric Circuit – Enclosure : 5kV Between Transducer Circuits : 5 kV Transducer Circuit – Control Circuit : 5 kV Between Electric Circuits : 3 kV Between Contacts Terminals : 3 kV	IEC60255-5

2.3.2 Electromagnetic Compatibility Tests

1MHz burst disturbance	Vibrating Frequency : 1MHz Voltage Rising Time : 75nsec Repeating Frequency : 400Hz Output Impedance : 200Ω Applying Method : Asynchronous Polarity : Positive, Negative Control Source Circuit Common Mode 2.5 kV Differential Mode 1.0 kV Transducer Circuit Common Mode 2.5 kV Differential Mode 1.0 kV Contact Circuit Common Mode 2.5 kV Differential Mode 1.0 kV	IEC60255-22-1 ANSI/IEEE C37.90.1
Fast transients / burst	Voltage Rising Time : 5nsec 50% Peak Voltage Holding Time : 50nsec Repeating Frequency : 2.5kHz Burst Holding Time : 15msec Burst Period : 300msec Applying Method : Asynchronous, Common Mode Polarity : Positive, Negative Applied Time : 1min Halted Time : 1min Control Source Circuit : 4 kV Transducer Circuit : 4 kV I/O Contact Circuit : 4 kV Ground Circuit : 4 kV	IEC60255-22-4 class Ⅳ, ANSI/IEEE C37.90.1
Electrostatic discharge	Polarity : Positive, Negative Applied Count : 10 times Applied Interval : 1sec Applied Part – Enclosure Contact Mode : 6.0 kV Air Mode : 8.0 kV	IEC60255-22-2 class Ⅲ

Compound Surge	Voltage Waveform : 1.2 × 50μsec Current Waveform : 8 × 20μsec Output Impedance : 2Ω Applying Method : Asynchronous Polarity : Positive, Negative Applied Count : 3 times Applied Interval : 30sec Control Source Circuit Common Mode 2.0 kV Differential Mode 1.0 kV Transducer Circuit Common Mode 2.0 kV Differential Mode 1.0 kV Contact Circuit Common Mode 2.0 kV Differential Mode 1.0 kV	IEC60255-22-5 class Ⅳ
Radiated Susceptibility	Applied Frequency :25MHz ~ 1GHz Electric Field Strength : 10V/m 80% AM modulation Applying Method : Front Distance from Antenna: Cross and Horizontality Dwell Time : 1sec	IEC60255-22-3 class Ⅲ ANSI/IEEE C37.90.2

2.3.3 Mechanical Tests

Vibration	Frequency: 16.7 Hz Wide: 0.4 mm Direction: front/back/left/right/top/bottom Time: 600 sec (10 min)	IEC60255-21-1 class Ⅱ
Impulse	Volume: 30 g (g: Acceleration of gravity) Applying Method :front/back/left/right/top/bottom - twice per each, total six times	IEC60255-21-2 class Ⅱ

2.3.4 Environmental Conditions

Temperature	-20 °C ~ +70 °C
Humidity	Daily average ~ 100 %
Altitude	<2000 m
No abnormal vibration, impact, inclination, or magnetic field effect	
No explosive/combustible dust, combustible/corrosive gas, or salinity	

3 Functional Description

3.1 PROTECTION FUNCTIONS

3.1.1 Over Voltage

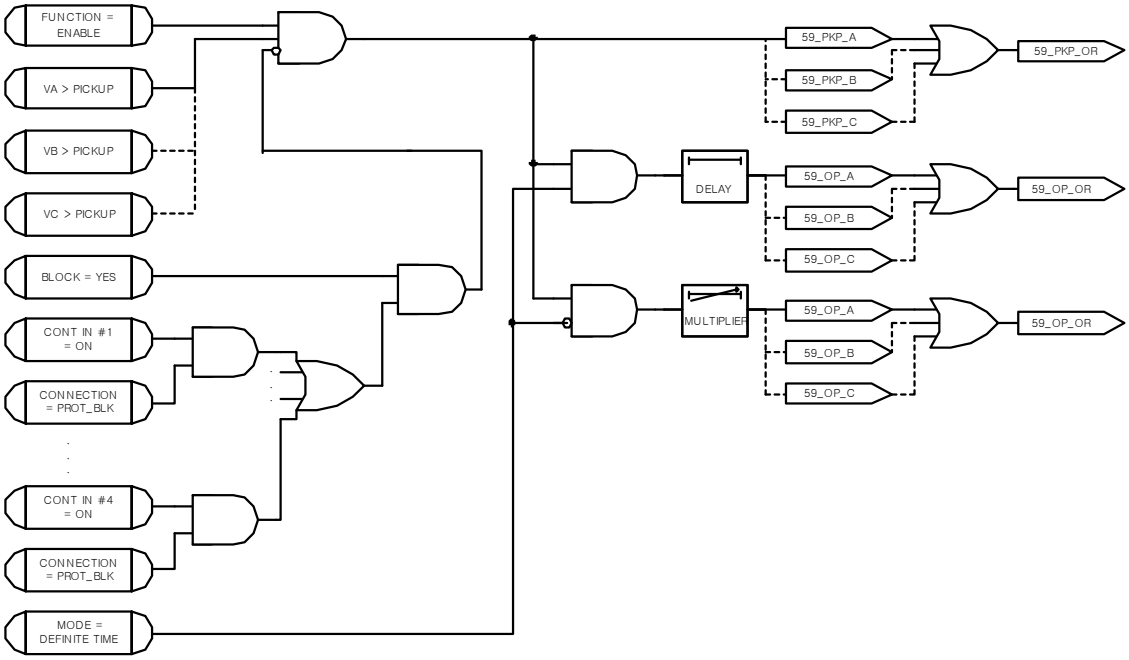
PAC-E500 has 2 over voltage protection elements (OV1 (59_1), OV2 (59_2)), is going to use them at the same time. This protection detects the fault using Phase Voltage values.

In case of the voltage higher than pick-up, it operates Definite Time characteristic that has operate time as 'DELAY' when 'MODE' is 'DEFINITE TIME', and Inverse Time Delayed characteristic is a has operate time as 'MULTIPLIER' when 'MODE' is 'INVERSE CURVE'

Inverse Time Delayed characteristic can be represented as the following functions.

$$T = \left(\frac{10.5}{\left(\frac{V}{Vs} \right)^{1.75} - 1} \right) \times TM\,(\sec)$$

T : Trip time in second V : Voltage input Vs : Pickup Voltage setting
TM : Time multiplier Trip time for V/Vs ≥8 are identical to those for V/Vs = 8.



VA/VB/VC: A/B/C phase Feeder Voltage

FUNCTION: Setting Function of Over Voltage
MODE: Setting Mode of Over Voltage
PICKUP: Setting Pickup of Over Voltage
DELAY: Setting Delay of Over Voltage
Multiplier: Setting Multiplier Over Voltage
BLOCK: Setting Block of Over Voltage
CONNECTION-PROT_BLK: Connection of Contact input is shown PROT_BLK
CONT IN #1~#4-1: Contact input is LOGIC "1"

59_PKP_A/B/C: Each phase pickup for Over Voltage
59_PKP_OR: The least 1 phase for Over Voltage is pickup
59_OP_A/B/C: Each phase Operation for Over Voltage
59_OP_OR: The least 1 phase for Over Voltage is Operation

<Figure 3.1.1. OV1 (59_1), OV2 (59_2) Logic Diagram>

3.1.2 Under Voltage

PAC-E500 has 2 under voltage protection elements (UV1 (27_1), UV2 (27_2)), is going to use them at the same time. This protection detects the fault using Phase Voltage values.

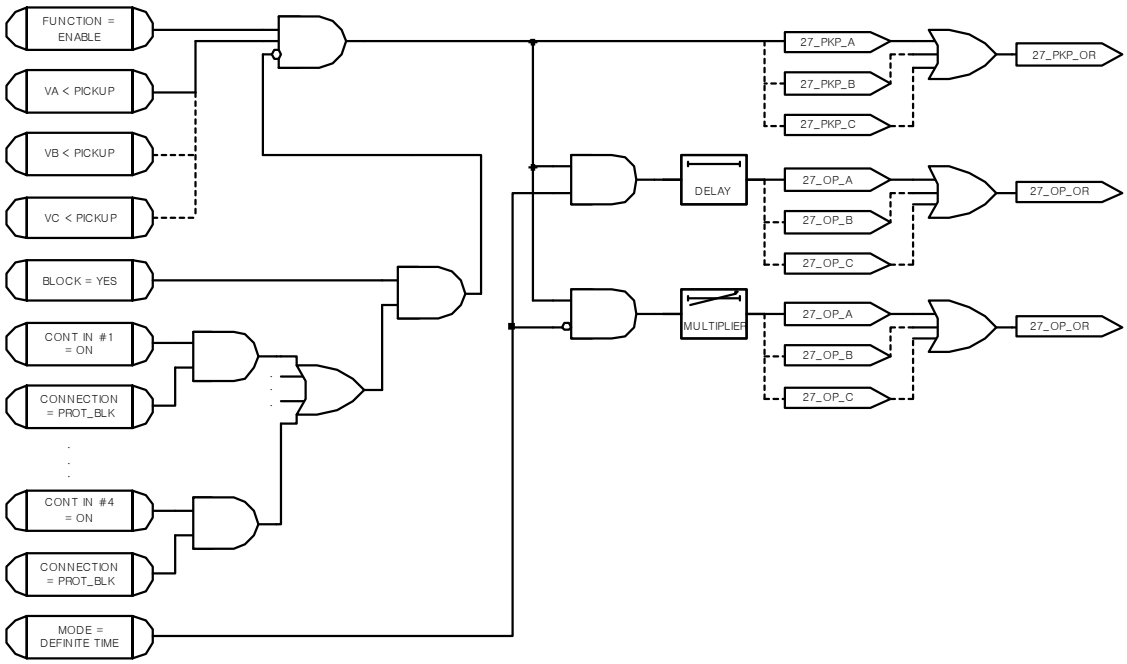
In case of the voltage lower than pick-up, it operates Definite Time characteristic that has operate time as 'DELAY' when 'MODE' is 'DEFINITE TIME', and Inverse Time Delayed characteristic is a has operate time as 'MULTIPLIER' when 'MODE' is 'INVERSE CURVE'

Inverse Time Delayed characteristic can be represented as the following functions.

$$T = \left(\frac{8}{1 - \left(\frac{V}{Vs} \right)^{2.2}} \right) \times TM(\sec)$$

T : Trip time in second V : Voltage input Vs : Pickup Voltage setting
TM : Time multiplier

Logic Diagram of Under Voltage element operation is as follows.



VA/VB/VC: A/B/C phase Feeder Voltage

FUNCTION: Setting Function of Under Voltage
MODE: Setting Mode of Under Voltage
PICKUP: Setting Pickup of Under Voltage
DELAY: Setting Delay of Under Voltage
Multiplier: Setting Multiplier Under Voltage
BLOCK: Setting Block of Under Voltage
CONNECTION-PROT_BLK: Connection of Contact input is shown PROT_BLK
CONT IN #1~#4-1: Contact input is LOGIC "1"

27_PKP_A/B/C: Each phase pickup for Under Voltage
27_PKP_OR: The least 1 phase for Under Voltage is pickup
27_OP_A/B/C: Each phase Operation for Under Voltage
27_OP_OR: The least 1 phase for Under Voltage is Operation

<Figure 3.1.2. . UV1 (27_1), UV2 (27_2) Logic Diagram >

3.1.3 Ground Over Voltage

PAC-E500 has 3 ground over voltage protection elements (OVG1 (59G_1), OVG2 (59G_2), OVG3 (59G_3)), is going to use them at the same time. This protection detects the fault using Ground Over Voltage values.

In case of the ground voltage higher than pick-up, it operates Definite Time characteristic that has operate time as 'DELAY' when 'MODE' is 'DEFINITE TIME', and Inverse Time Delayed characteristic is a has operate time as 'MULTIPLIER' when 'MODE' is 'INVERSE CURVE'. Inverse Time Delayed characteristic has 2 curves, 'Trip' and 'Alarm'.

Inverse Time Delayed characteristic can be represented as the following functions.

- Inverse Trip Curve

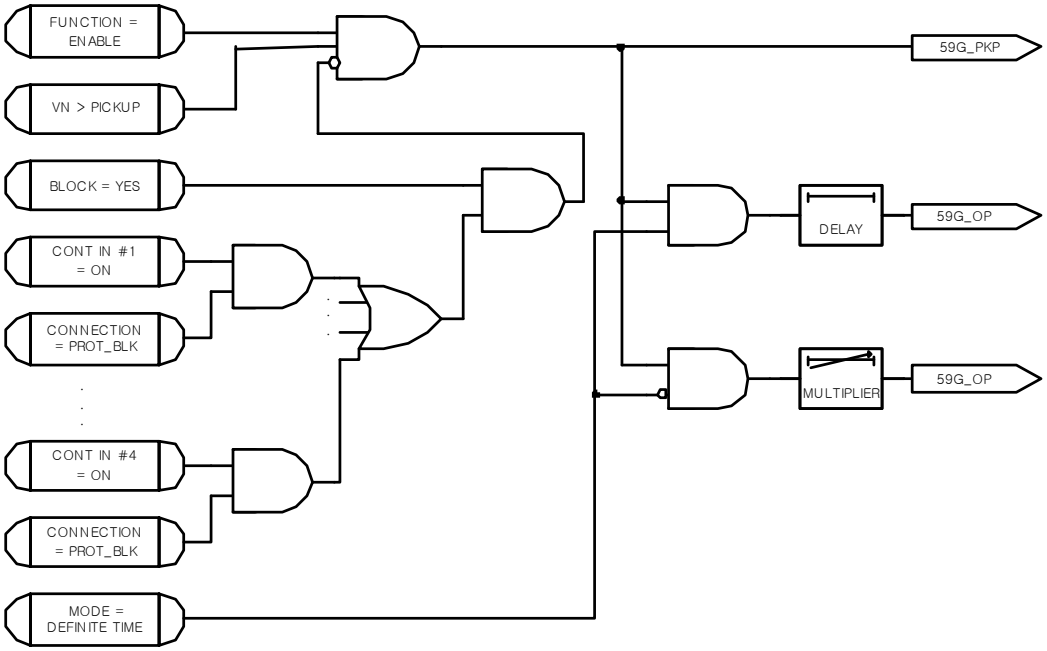
$$T = \left(\frac{12.15}{\left(\frac{V}{Vs}\right)^{2} - 1} + 0.35 \right) \times TM(\sec)$$

-Inverse Alarm Curve

$$T = \left(\frac{24.75}{\left(\frac{V}{Vs}\right)^{2.23} - 1} + 4.15 \right) \times TM(\sec)$$

T : Trip time in second V : Voltage input Vs : Pickup Voltage setting
TM : Time multiplier Trip time for V/Vs $\geq$8 are identical to those for V/Vs = 8.

Logic Diagram of 3 phase Ground Over Voltage element operation is as follows.



VN: Feeder Ground Voltage

FUNCTION: Setting Function of Ground Over Voltage
MODE: Setting Mode of Ground Over Voltage
PICKUP: Setting Pickup of Ground Over Voltage
DELAY: Setting Delay of Ground Over Voltage
Multiplier: Setting Multiplier Ground Over Voltage
BLOCK: Setting Block of Ground Over Voltage
CONNECTION-PROT_BLK: Connection of Contact input is shown PROT_BLK
CONT IN #1~#4-1: Contact input is LOGIC "1"

59G_PKP: Pickup for Ground Over Voltage
59G_OP: Operation for Ground Over Voltage

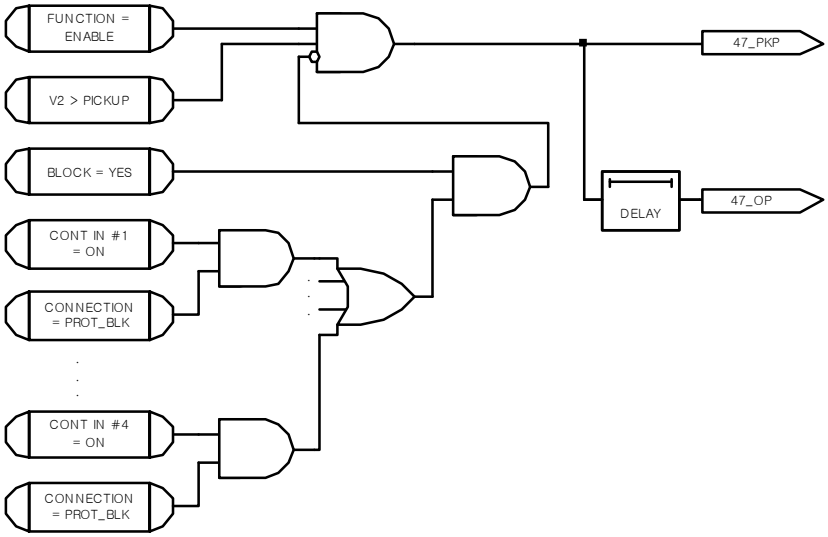
<Figure 3.1.3. OVG1 (59G_1), OVG2 (59G_2), OVG3 (59G_3) Logic Diagram>

3.1.4 Negative Phase Sequence Over Voltage

Negative Phase Sequence Over Voltage protection detects the fault using Negative Phase Voltage values.

In case of the negative phase voltage higher than pick-up, it operates Definite Time characteristic that has operate time.

Logic Diagram of Under Current element operation is as follows.



V2: Negative Phase Feeder Voltage

FUNCTION: Setting Function of Negative Phase Sequence Over Voltage
PICKUP: Setting Pickup of Negative Phase Sequence Over Voltage
DELAY: Setting Delay of Negative Phase Sequence Over Voltage
BLOCK: Setting Block of Negative Phase Sequence Over Voltage
CONNECTION-PROT_BLK: Connection of Contact input is shown PROT_BLK
CONT IN #1~#4-1: Contact input is LOGIC "1"

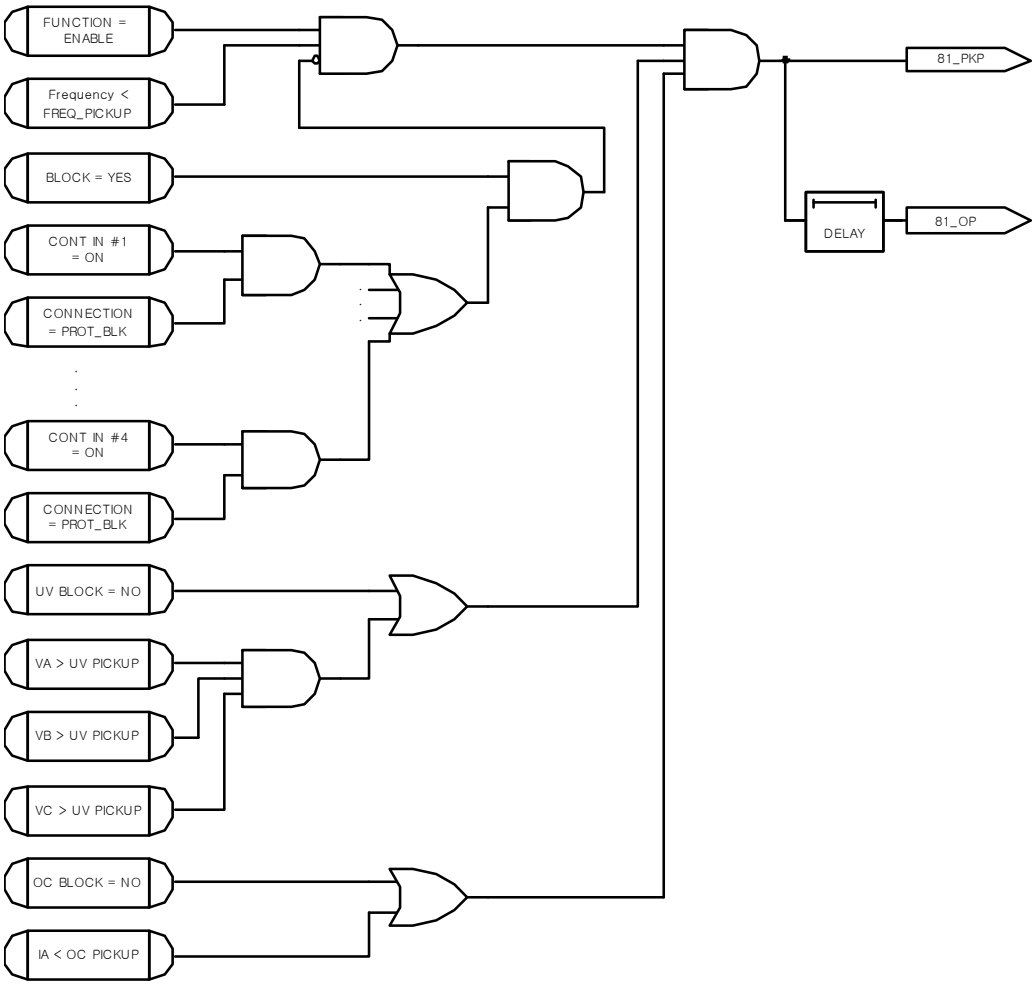
47_PKP: Pickup for Negative Phase Sequence Over Voltage
47_OP: Operation for Negative Phase Sequence Over Voltage

<Figure 3.1.4 NSOV (47) Logic Diagram>

3.1.5 Under Frequency

Under Frequency protection detects the fault using frequency value of A-phase voltage. In case of the frequency of A-phase voltage lower than FREQ PICKUP, it operates and requisite fault detection is added when each 'Block' element is set. Voltage is input lower than 'UV PICKUP' when UV PICKUP is set and in case of under frequency the protection element doesn't operate blocked. And 'OC BLOCK' and 'dF/dT BLOCK' operate in the same way.

Logic Diagram of Under Frequency element operation is as follows.



Frequency: Frequency of A-phase feeder voltage
VA/VB/VC: A/B/C phase feeder voltage
IA: A-phase feeder current

FUNCTION: Setting Function of Under Frequency
FREQ PICKUP: Setting FREQ PICKUP of Under Frequency e
DELAY: Setting Delay of Under Frequency
UV BLOCK: Setting Under Voltage Block of Under Frequency
OC BLOCK: Setting Over Current Block of Under Frequency
BLOCK: Setting Block of Under Frequency
CONNECTION-PROT_BLK: Connection of Contact input is shown PROT_BLK
CONT IN #1~#4-1: Contact input is LOGIC "1"

81_PKP: Pickup for Under Frequency
81_OP: Operation for Under Frequency

<Figure 3.1.5. UF (81) Logic Diagram>

3.2 ADDITIONAL FUNCTIONS

3.2.1 Control

PAC-E500 supports direct CB Trip/Close control function (One CB).

Control functions of PAC-E500 also provide a local/remote selection for control location. As for remote control, PAC-E500 communicates with an upper master system (SCADA) through the rear RS485 port (Protocol: Modbus).

To control CB, a contact input should be allocated for CB STATUS input (CB_OPENED or CB_CLOSED). If there are many contact inputs allocated for CB status, "Contact Input #1" status is the first priority for CB control.

In case no contact input is allocated for CB status, CB control function is not available and all LEDs related to CB control (Local/Remote, Open/Close) are off.

Local / Remote (L/R) Control Position

To control the circuit breaker, the operator must get the appropriate right to control. The Local/Remote button renders CB control right to the local operators on site or to the remote operators in control center. Remote operator cannot control CB on the local mode, and vice versa. Security check by password inhibits the random mode change.

To change the control position mode (Local to Remote and Remote to Local), press L/R button and enter the password using arrow keys and ENT key. After correct password input, local and remote control positions can be toggled.

CB OPEN / CLOSE

This function performs trip (open)/close control actions of CB. CB Open or Close button on the front panel is activated only on the Local mode ("L" LED on). On the Remote mode, only control command from SCADA through communication is accepted.

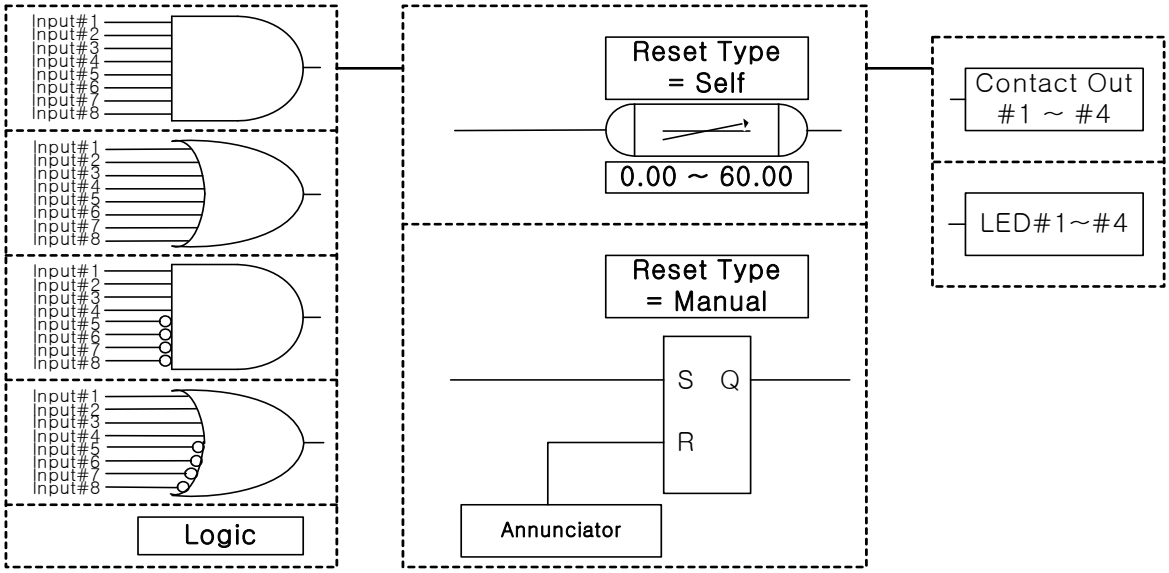
Before control command via front panel, SELECT button and Password enter are required first. SELECT button is the concept to prevent the mal-operation on the front panel and this concept is the same with SBO (Select Before Operate) concept in communication protocol, i.e. DNP3.0, where SCADA (master system) selects first the equipment to control remotely before setting out actual control command to keep other masters from selecting the same equipment so that control right is granted to that SCADA only. This dedicated concept is adopted equally to Local control and this is also used for mal-operation prevention of direct open/close command. After the correct password enter and SELECT button again, then a phrase that CB is selected is displayed on LCD and SELECT LED is blinking. After while, CB OPEN/CLOSE buttons are activated for 15 seconds.

3.2.2 Measurement & Metering

Current	RMS Current value of fundamental component & phase angle of A-phase Range: 0.01 ~ 50 * In RMS Measuring accuracy: ± 2 % (0.10 ~ 0.20 * In) ± 0.5 % (0.20 ~ 1.20 * In) ±1.0 % (> 1.20 * In)
Voltage	RMS Voltage value of fundamental component & phase angle per phase and line-to-line Metering range: 2.00~999.99V (Phase voltage) 2.00~999.99V (line-to-line voltage)
Frequency	Measured based on A-phase voltage Metering range: 40 ~ 70 Hz Measuring Accuracy: ± 0.03 Hz
Sequence	Positive, Negative, Zero Sequence Values of Current

3.2.3 Programmable Logic

Input	CB Open/Close control, Protection element is pickup, Self-diagnosis, Contact Input
Logic	OR8 (8 input OR) HALF-OR8 (Non inverting 4 input & inverting 4 input OR) AND8 (8 input AND) HALF-AND8 (Non inverting 4 input & inverting 4 input AND)
Reset Type	Self (latched until delay timer is expired) Manual (latched until annunciator reset is issued)
Reset Delay	0.00 ~ 60.00 sec (0.01 sec step)
Feature	Control contact output and LED using Logic



<Figure 3.2.3. Logic Design (Contact Output & LED)>

Input Group	Input	Description
Logic	L_OFF	Logic '0'
	L_ON	Logic '1'
CB Control	CB_OPEN_CTL	CB Open Control (Local or Remote)
	CB_CLOSE_CTL	CB Close Control (Local or Remote)
Contact Input	CONT_IN #1	Contact input#1 status
	…	…
	CONT_IN #4	Contact input#4 status
System	SYS_ERR	Self-diagnosis error is occurred
Protection elements	PROT_PKP_OR	Any protection element is picked up
	PROT_OP_OR	Any protection element is operated
	59_1_PKP_OR	At least 1 phase of 59_1 is picked up
	59_1_PKP_A	Phase A of 59_1 is picked up
	59_1_PKP_B	Phase B of 59_1 is picked up
	59_1_PKP_C	Phase C of 59_1 is picked up
	59_1_OP_OR	At least phase of 59_1 is operated
	59_1_OP_A	Phase A of 59_1 is operated
	59_1_OP_B	Phase B of 59_1 is operated
	59_1_OP_C	Phase C of 59_1 is operated
	59_2_PKP_OR	At least 1 phase of 59_2 is picked up
	59_2_PKP_A	Phase A of 59_2 is picked up
	59_2_PKP_B	Phase B of 59_2 is picked up
	59_2_PKP_C	Phase C of 59_2 is picked up
	59_2_OP_OR	At least phase of 59_2 is operated
	59_2_OP_A	Phase A of 59_2 is operated
	59_2_OP_B	Phase B of 59_2 is operated
	59_2_OP_C	Phase C of 59_2 is operated
	27_1_PKP_OR	At least 1 phase of 27_1 is picked up
	27_1_PKP_A	Phase A of 27_1 is picked up
	27_1_PKP_B	Phase B of 27_1 is picked up
	27_1_PKP_C	Phase C of 27_1 is picked up
	27_1_OP_OR	At least phase of 27_1 is operated
	27_1_OP_A	Phase A of 27_1 is operated
	27_1_OP_B	Phase B of 27_1 is operated
	27_1_OP_C	Phase C of 27_1 is operated
	27_2_PKP_OR	At least 1 phase of 27_2 is picked up
	27_2_PKP_A	Phase A of 27_2 is picked up
	27_2_PKP_B	Phase B of 27_2 is picked up
	27_2_PKP_C	Phase C of 27_2 is picked up
	27_2_OP_OR	At least phase of 27_2 is operated
	27_2_OP_A	Phase A of 27_2 is operated
	27_2_OP_B	Phase B of 27_2 is operated
	27_2_OP_C	Phase C of 27_2 is operated

	59G_1_PKP	59G_1 is picked up
	59G_1_OP	59G_1 is operated
	59G_2_PKP	59G_2 is picked up
	59G_2_OP	59G_2 is operated
	59G_3_PKP	59G_3 is picked up
	59G_3_OP	59G_3 is operated
	47_PKP	47 is picked up
	47_OP	47 is operated
	81_PKP	81 is picked up
	81_OP	81 is operated
	PT_FUSE_FAIL	PT_FUSE_FAIL is operated

<Table 3.2.3. Logic Input Table>

3.2.4 Self Diagnosis

As monitoring internal operating status, self-diagnosis function is provided to prevent the mal-operations of PAC-E500 internal systems. When any abnormality is detected for diagnosis items, ERROR LED on front panel is on and SYSTEM ERROR message is displayed on LCD. The diagnosis status for each item is listed on LCD in the menu of DISPLAY/STATUS/SELF DIAGNOSIS. After fixing the trouble and RESET button, this ERROR status is reset.

Main diagnosis items are as follows.

- □ Memory
- □ Setting
- □ A/D Converter
- □ Calibration

3.2.5 Communication

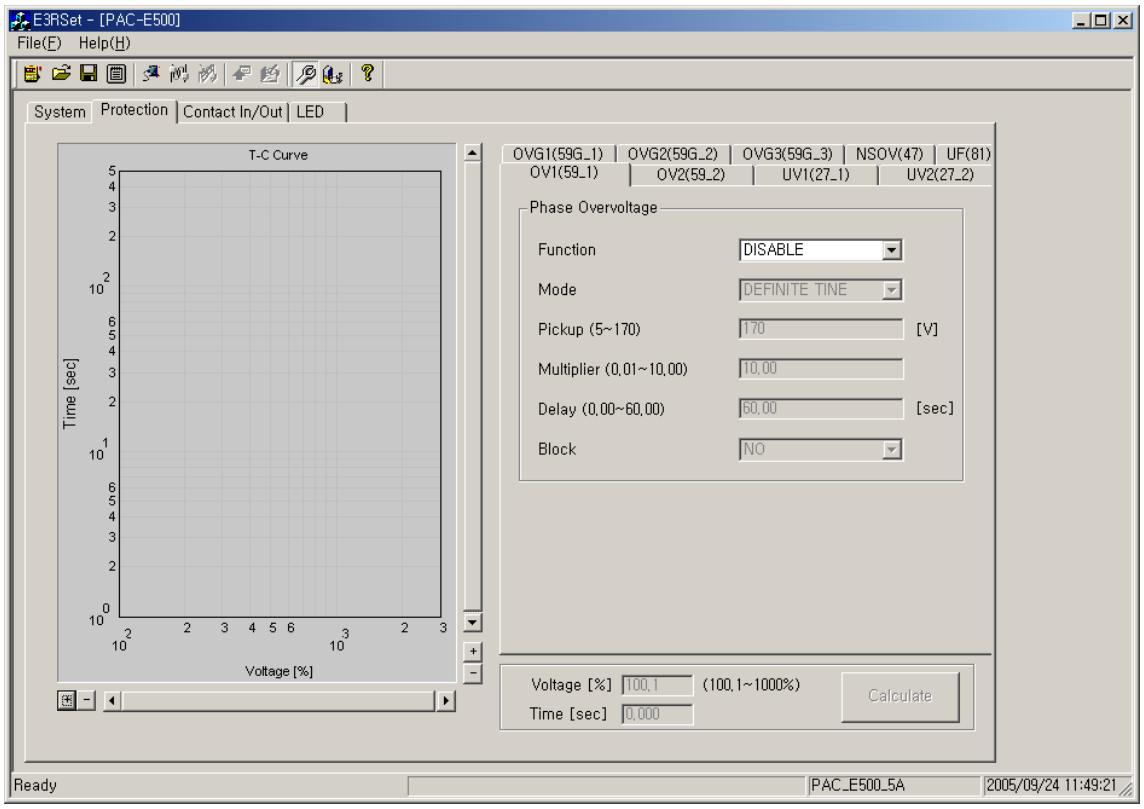
Front	1 RS232 Port (19200 BPS, ModBus Protocol) ➔ For maintenance and Setting software (Engineering Tool)
Rear	1 RS232 Port (19200 BPS, ModBus Protocol) ➔ For maintenance and Setting software (Engineering Tool) 1 RS485 Port (300 ~ 38400 BPS, DNP3.0/Modbus/ IEC870-5-103 Protocol) ➔ For SCADA communication

3.2.6 Setting & Configuration Software

PAC-E500 has the dedicated setting software. Through RS232 port on front or rear panel of PAC-E500 to notebook computer's RS232 port, maintenance and batch jobs are easily done. In the following, the functions of this tool are described briefly.

- □ System Configuration & Set Value Upload to PC and Batch Download to PAC-E500
- □ Set Value & Recorded Data Saving

The manipulation of setting software is explained in more detail on chapter 6 and the following figure shows protection page of setting program.



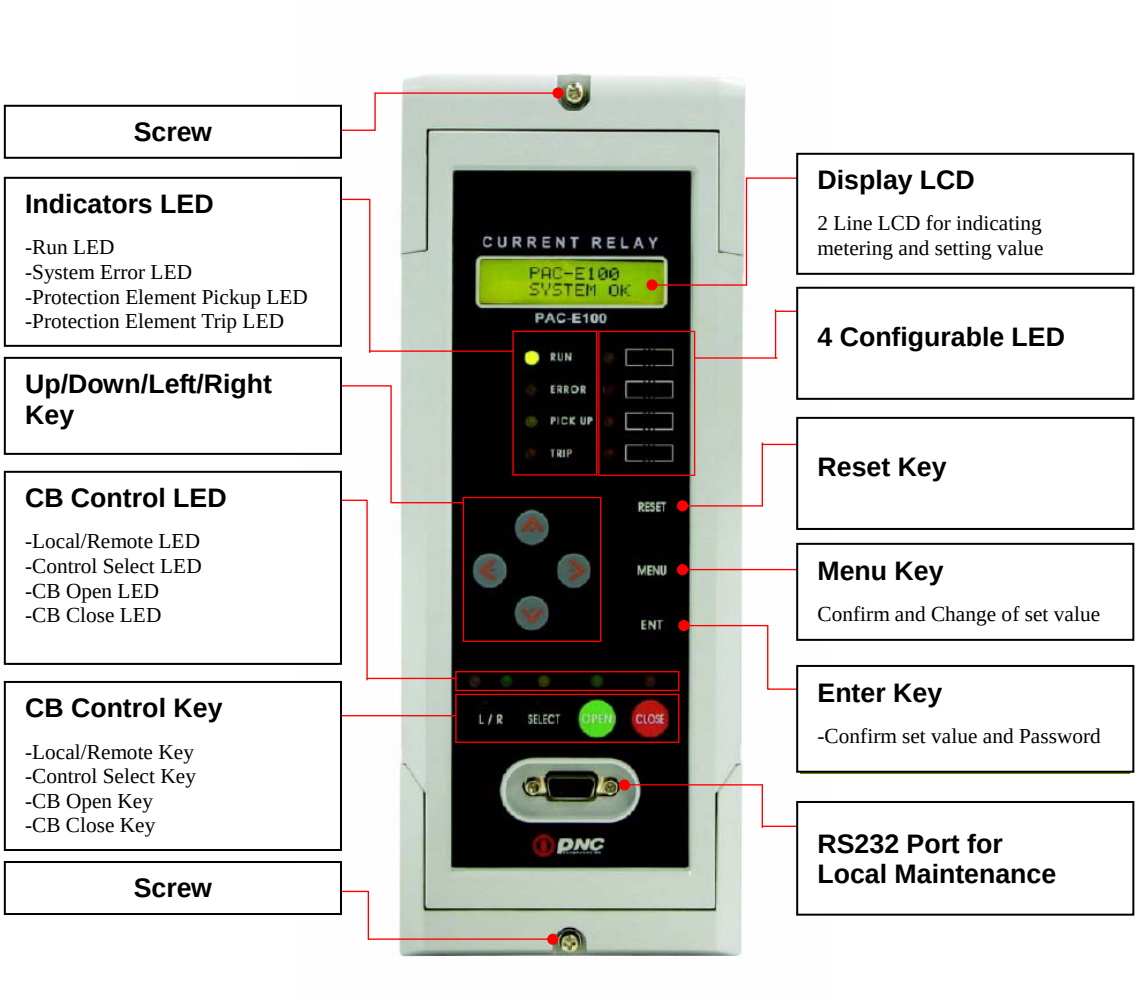
<Figure 3.2.6. Protection Page of Setting software >

4 Operational Description

4.1 FRONT PANEL CONSTRUCTION

4.1.1 Front Panel Operation

The front-face display panel of PAC-E500 is composed of a graphic LCD 16 char × 2 lines, 13 LED's, 11 keypad buttons, and a RS232C communication port. Cover put on front panel play part that keep away invasion of dust and unnecessary button operation. Password protection prevents the unexpected mal-operation of keypad for control. The protection functions are executed in the background even during the manipulations of keypad. The alternative way to communicate with PAC-E500 for settings modification and fault/event data upload is to use the engineering tools through RS232C port in the front-face.



<Figure 4.1.1. Front Panel Operator Interface>

4.1.2 LEDs

RUN (Green)	RUN: Green is on when power is supplied. Test: Green is on and blinking when contact outputs are set out and during LCD/LED test on front panel.
ERROR (Red)	Red is on when self-diagnosis function detects device abnormalities. Relaying operation is inhibited. Details of abnormality are displayed on LCD, and even if the abnormal state returns to normal, LED is not reset to off but latched on. Manual RESET only returns to reset status.
PICK UP (Yellow)	Yellow is on when a protection element is picked up.
TRIP (Red)	Red is on when any trip signal is outputted. LED is latched on until manual RESET.
Programmable LED * 4 (Red)	Red is on when each logic status (contact outputs #1~#4) is 1 (ON). Reset depends on Reset Type (Self/Manual) and Reset Delay time (0.00~60.00sec).
L (Red)	Red is on in L/R LEDs when LOCAL control mode. (Any contact input should be allocated for CB status and password is required for control mode change.)
R (Green)	Green is on in L/R LEDs when REMOTE control mode. (Any contact input should be allocated for CB status and password is required for control mode change.)
SELECT (Yellow)	Yellow is blinking when CB control is SELECTed.
OPEN (Green)	Green is on when contact input CB status is OPEN. (Any contact input should be allocated for CB status.)
CLOSE (Red)	Red is on when contact input CB status is CLOSE. (Any contact input should be allocated for CB status.)

4.1.3 Keypad

ARROW	UP	Menu Move, Value Change
	DOWN	
	RIGHT	Menu Move, Menu Item Selection
	LEFT	Menu Move, Escape to Upper Menu / Cancel Item
RESET		Manual Reset of System Error and Trip LED
MENU		Enter into Menu Tree Display
ENT		Setting Value Enter and Confirm
CONTROL (Password)	L / R	Local / Remote Control Mode Change
	SELECT	CB Control Selection
	OPEN	CB Trip Control
	CLOSE	CB Close Control

4.2 KEY MANIPULATION & MENU

4.2.1 Basic Principle of Key Manipulation

LCD display of PAC-E500 mainly consists of Initial Display and Menu Tree Display.

And Menu Tree Display is entered through MENU keypad button. Two display modes are alternated by MENU and Left keypad buttons. In the Menu Tree Display, 4 arrow keys determine the tree node and value change, and ENT key sets the determined values. All the menu items and set values take the rollover schemes using Up/Down keys.

[Setting Value Change]

1) All menus except PASSWORD display page numbers on the upper-right side of LCD. Press right arrow button on this page-numbered display.
2) If password is required, press ENTER button after inputting each digit of password. Right/Left keys are used to move cursor to each digit and Up/Down keys be used to input the password number/character of each digit.
3) After correct Password input and Right arrow key again, the set value is blinking to be ready for change.
4) After scrolling the required set value using Up/Down arrow keys, press ENT button. If Left arrow key is pressed before ENT button, the value is not changed and remains the previously saved value. This action confirms the input of a new set value.
5) Using Left arrow key a few times as exiting SETTING menu, the changed set values are saved in the memory to confirm the change save to YES.
6) Entering password into SETTING menu is required once for several value changes until exiting SETTING menu.

[Control Position Mode Change: Local / Remote]

1) Only if one or more contact inputs are allocated for CB Open/Closed status, CB control and related status are activated. In case all LEDs for control and related status are off, please check first the configuration of contact inputs and set contact input for CB status.
2) To change the CB control position between Local from control panel and Remote from SCADA (master system), press L/R button.
3) The password is required, and arrow keys and ENT button are used to input the password.
4) After correct password and L/R button again, control position is changed between Local (L) and Remote (R), and each LED (L: Red, R: Green) is toggled on and off.

[CB Control from Front Panel]

1) Only if one or more contact inputs are allocated for CB Open/Closed status, CB control and related status are activated. In case all LEDs for control and related status are off, please check first the configuration of contact inputs and set contact input for CB status.
2) In case the control position is Remote (R, Green LED is on.), it should be changed to Local (L, Red LED is on.) using the previous method of Control Position Mode Change.
3) Press SELECT button to confirm CB control intention.
4) The password is required for SELECT, and arrow keys and ENT button are used to input the password.
5) After correct password input, CB control is finally actuated using OPEN / CLOSE buttons. In case control command is the same with the current status of CB, the description of the same status (OPENED or CLOSED) is displayed on LCD and no control command goes out.
6) At all times, the password is required for CB control.

4.2.2 Menu Tree

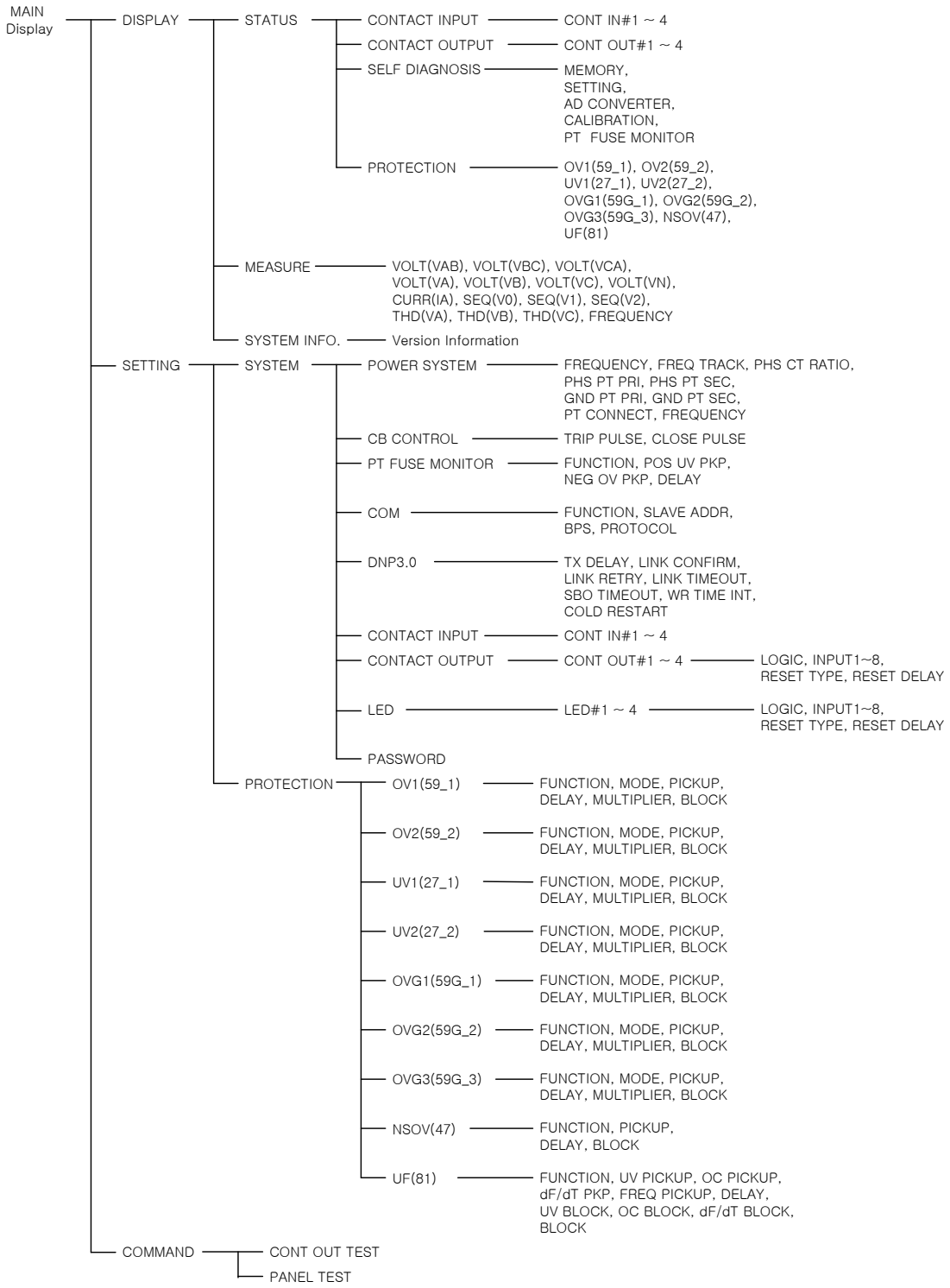
Menu of PAC-E500 mainly consists of DISPLAY, SETTING, and COMMAND.

DISPLAY menu is composed of STATUS, MEASURE, and SYS INFO sub menus. STATUS menu is used to monitor the statuses of input/output contacts, the results of self-diagnosis, and start/operated statuses of protection elements. MEASURE menu is used to display the measurement and metering of electric values, sequence current, and frequency. SYS INFO menu is used to display the system information of MPU and DSP S/W versions for maintenance.

SETTING menu is composed of SYSTEM and PROTECTION sub menus. This menu is used for settings modification. SYSTEM menu is composed of POWER SYSTEM, CB CONTROL, PT FUSE MONITOR, COM, DNP3.0, CONTACT INPUT, CONTACT OUTPUT, LED, and PASSWORD. POWER SYSTEM is used for setting of frequency, frequency tracking, phase CT ratio, Primary and Secondary of phase/ground PT and PT Connection. CB CONTROL is used for time setting TRIP and CLOSE PULSE. COM is used for communication setting. DNP3.0 is used for setting of DNP when communication method is DNP3.0. CONTACT INPUT / OUTPUT and LED are used for setting contact input/output and Programmable LED respectively. PASSWORD is used when change password.

PROTECTION menu is composed of protection elements, OV1 (59_1), OV2 (59_2), UV1 (27_1), UV2 (27_2), OVG1 (59G_1), OVG2 (59G_2), OVG3 (59G_3), NSOV (47) and UF (81), and is used setting each of protection elements.

COMMAND menu is composed of CONT OUT TEST and PANEL TEST sub menus. This menu is used to test output contacts and LCD/LEDs of front-face display panel.



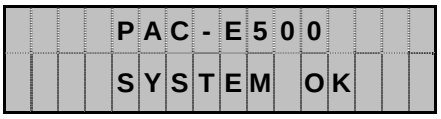
<Figure 4.2.2. PAC-E500 Overall Menu Tree>

4.3 INITIAL DISPLAY

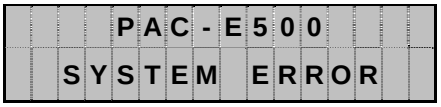
Initial display divides normal and error display according to self-diagnosis.

User takes proper action when self-diagnosis status except PT FUSE MONITOR is "FAIL" one or more and must reset manual after make normally self-diagnosis.

LCD is indicated SYSTEM OK, when result of self-diagnosis is OK as following.



LCD is indicated SYSTEM ERROR, when result of self-diagnosis is FAIL as following.



4.4 MENU TREE DISPLAY

To convert Initial Display into Menu Tree Display are operated through ENT and MENU buttons.

Menu Tree Display is entered through MENU keypad button. Two display modes are alternated by MENU and Left keypad buttons. In the Menu Tree Display, 4 arrow keys determine the tree node and value change, and ENT key sets the determined values. All the menu items and set values take the rollover schemes using Up/Down keys.

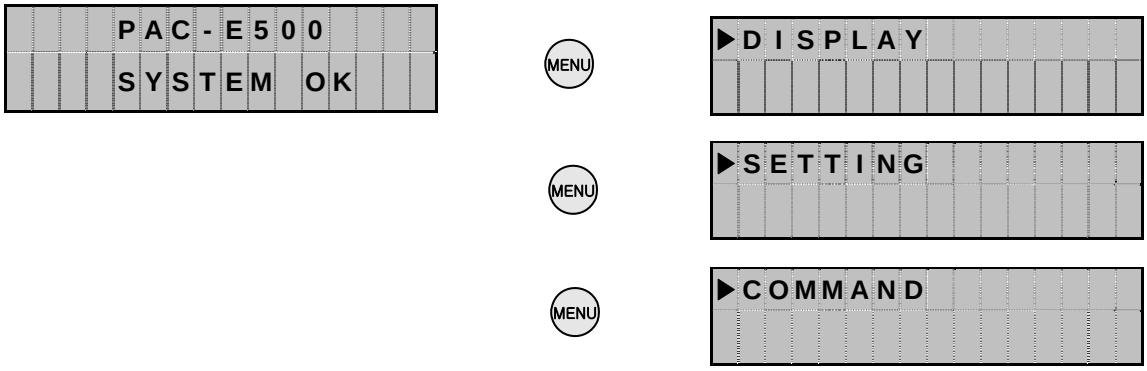
To convert Menu Tree Display into Initial Display are operated through Left arrow Escape keypad button and main menus first child nodes of the root consist of DISPLAY, SETTING, and COMMAND.

DISPLAY menu shows status of I/O contacts, self-diagnosis results, starting and operating status of protection elements, metering of electric values, and software version of DSP.

SETTING menu lets password for setting and control, analog circuit configuration, real-time system clock, CB setup, communication, input/output contacts and programmable LED setup, operation setup for protection elements, calibration data.

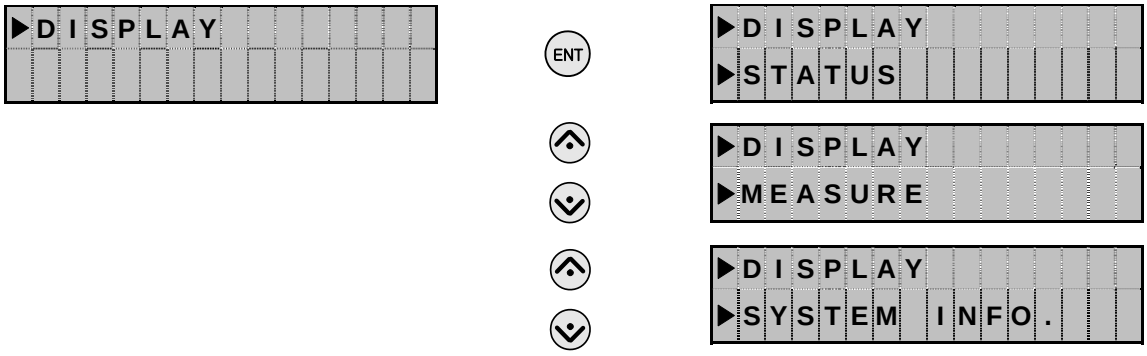
COMMAND menu is used to test output contacts and LCD/LEDs of front-face display panel.

In the following, each of the specific sub menus is explained.



4.4.1 DISPLAY Menu

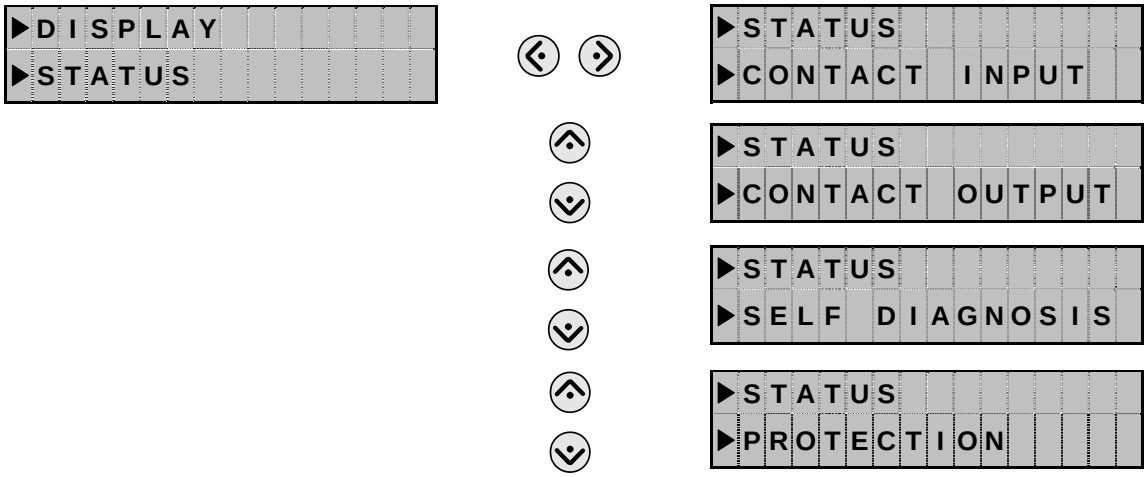
DISPLAY menu is composed of STATUS, MEASURE, and SYS INFO sub menus.



4.4.1.1. DISPLAY/STATUS

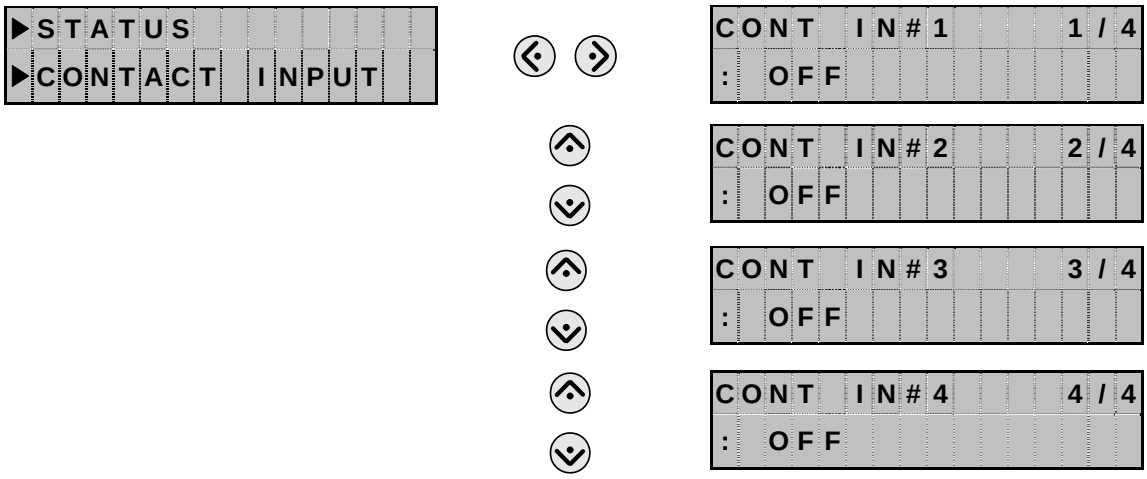
DISPLAY menu is composed of CONTACT INPUT, CONTACT OUTPUT, SELF DIAGNOSIS, and PROTECTION sub menu.

Each of sub menus shows contact input, contact output, self-diagnosis and operating status of protection elements.



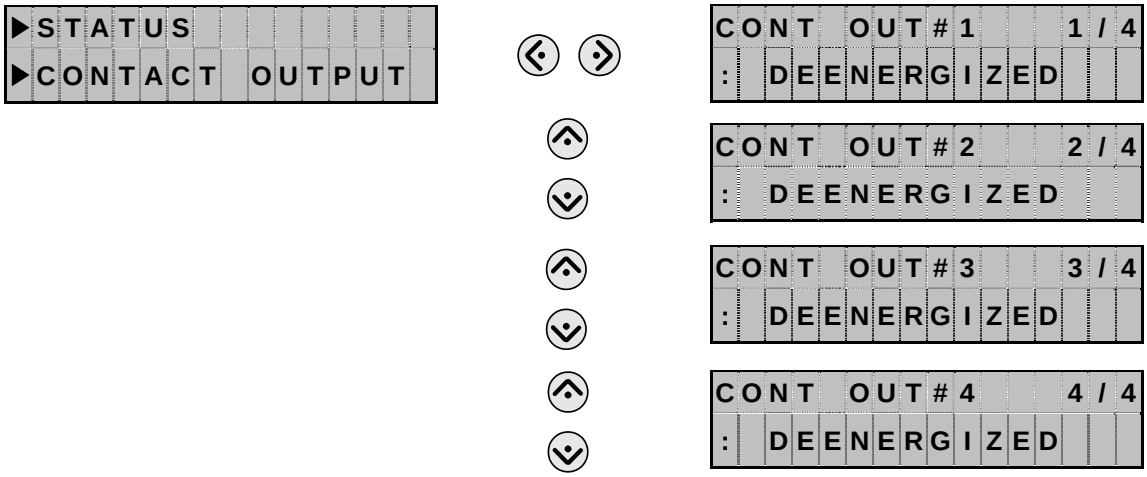
4.4.1.2. DISPLAY/STATUS/CONTACT INPUT

This menu displays On/Off status information of 4 contact inputs.



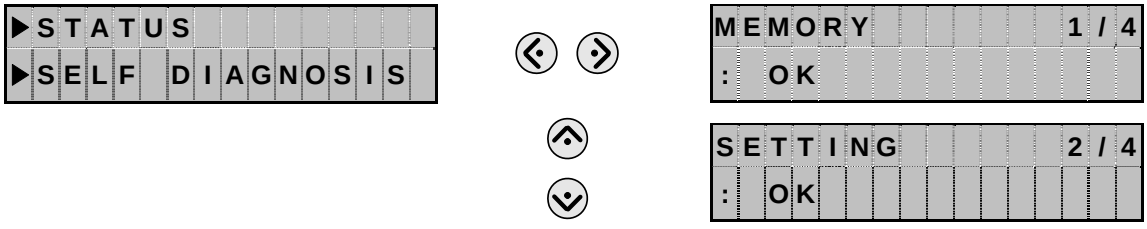
4.4.1.3. DISPLAY/STATUS/CONTACT OUTPUT

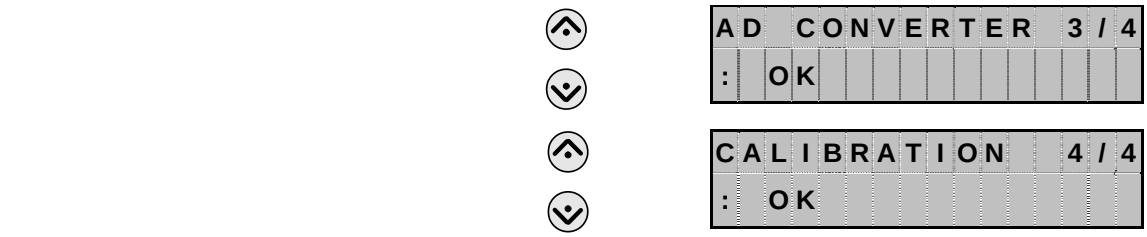
This menu displays On/Off status information of 4 contact outputs.



4.4.1.4. DISPLAY/STATUS/SELF DIAGNOSIS

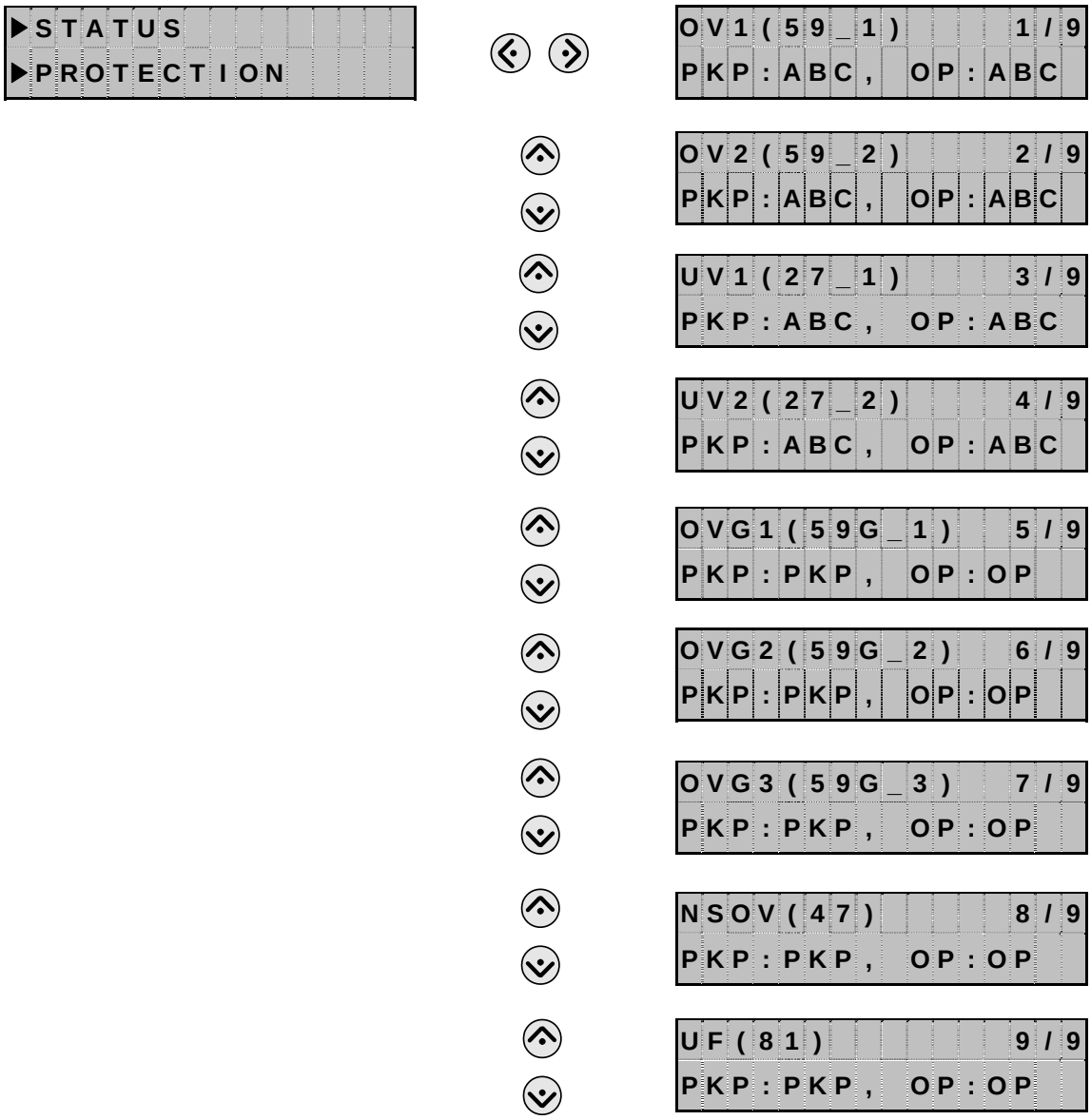
This menu displays self-diagnosis results. System works normally if status of all self-diagnosis except PT FUSE MONITOR is OK.





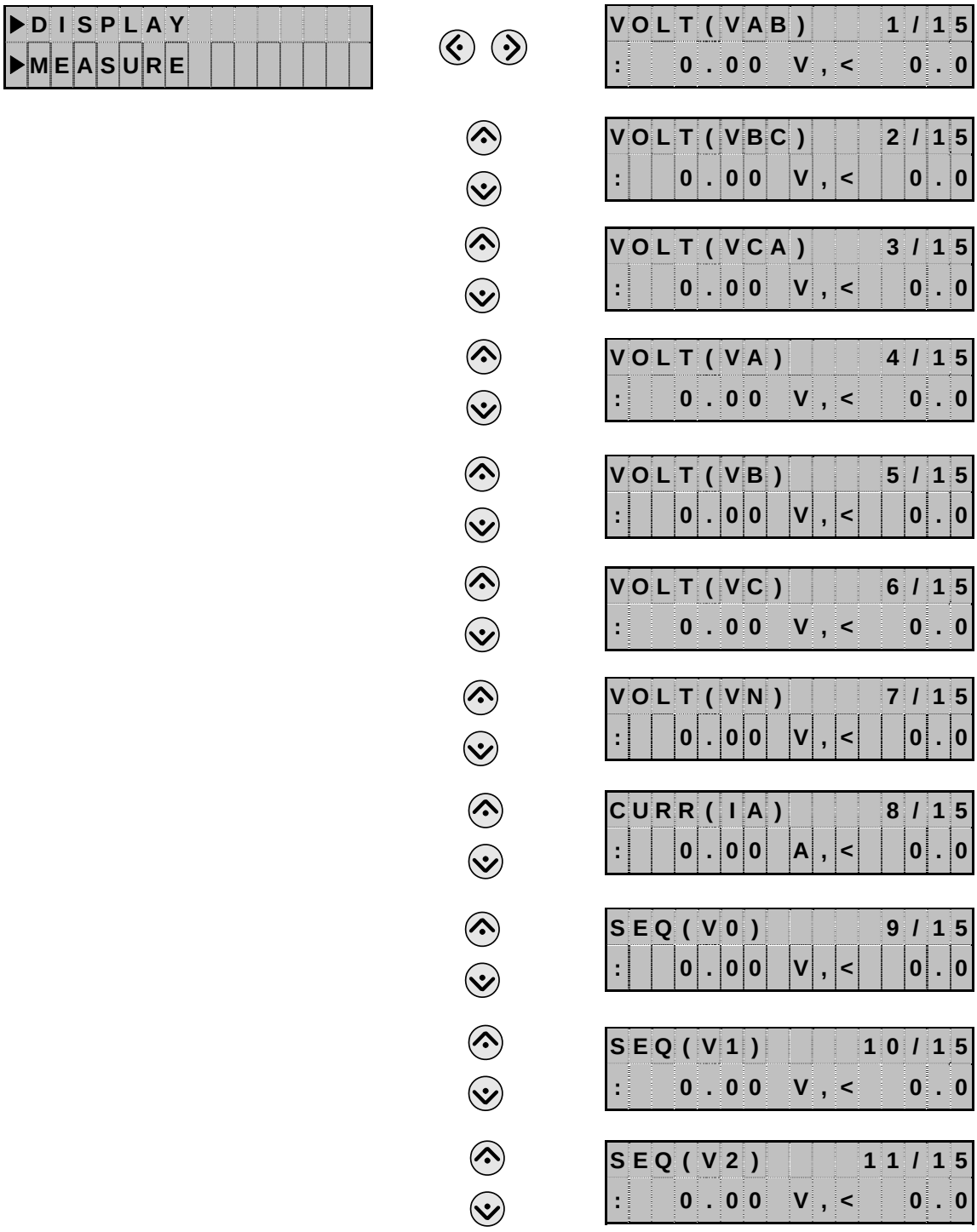
4.4.1.5. DISPLAY/STATUS/PROTECTION

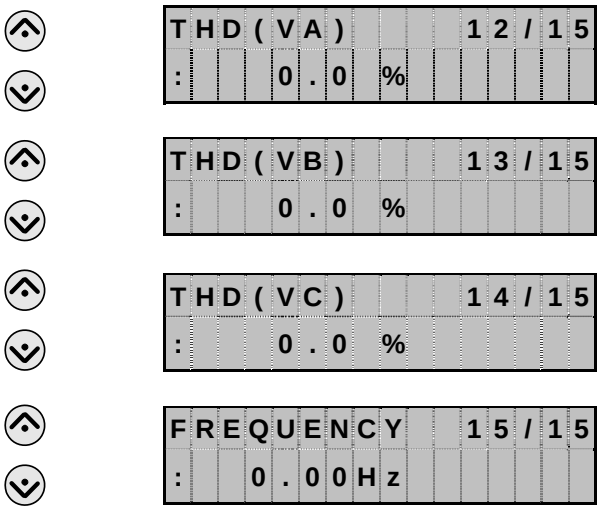
This menu displays picked-up started and operated status of 9 protection elements. Phase elements show started and operated phases A, B, and C, and ground elements show "PK" and "OP" symbols, when the fault current is picked up and the relaying element is signaled to operate.



4.4.1.6. DISPLAY/MEASURE

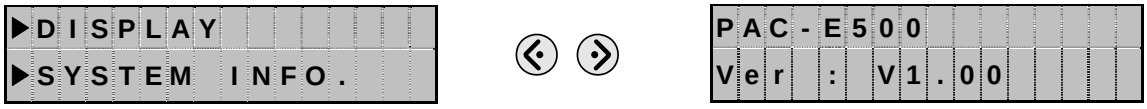
This menu displays measurement and metering data of electric values. PAC-E500 has 1 current input and 4-voltage input. (Frequency is show according to input value of A-phase voltage.)





4.4.1.7. DISPLAY/SYSTEM INFO.

This menu is used to display the system information of DSP S/W versions for maintenance.



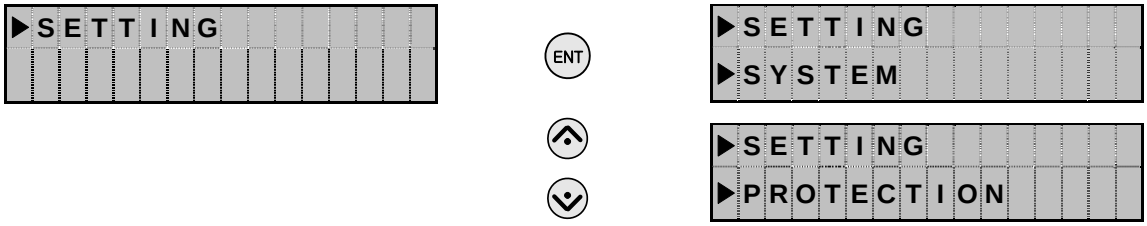
4.4.2 SETTING Menu

SETTING menu is composed of SYSTEM and PROTECTION sub menus. This menu is used for settings modification.

Basically, modifying settings and viewing are carried out in 2 ways: through LCD and keypad, and engineering tool batch download using Setting software.

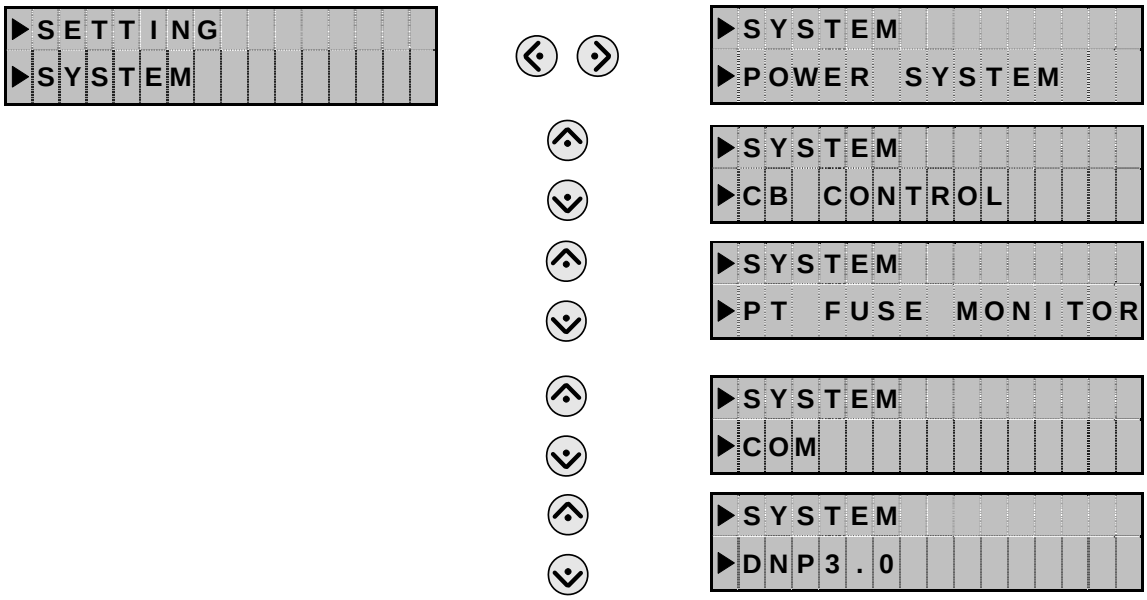
SETTING menu has 2 submenus; SYSTEM is for the general system setup and PROT COMP is for protection elements.

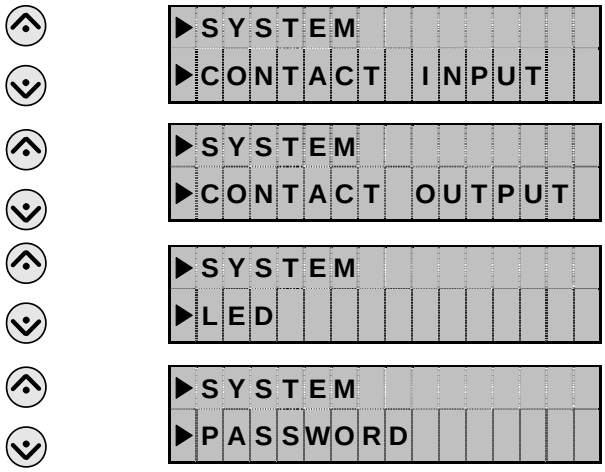
Password enter is always required when the setting values are to be changed, and the updated setting values are stored and reflected after yes/no confirmation escaping SETTING menu. And, once the password is entered using ENT key, it doesn't need to be entered again while in SETTING menu. New values are set and selected using arrow keys and ENT keypad button.



4.4.2.1. SETTING/SYSTEM

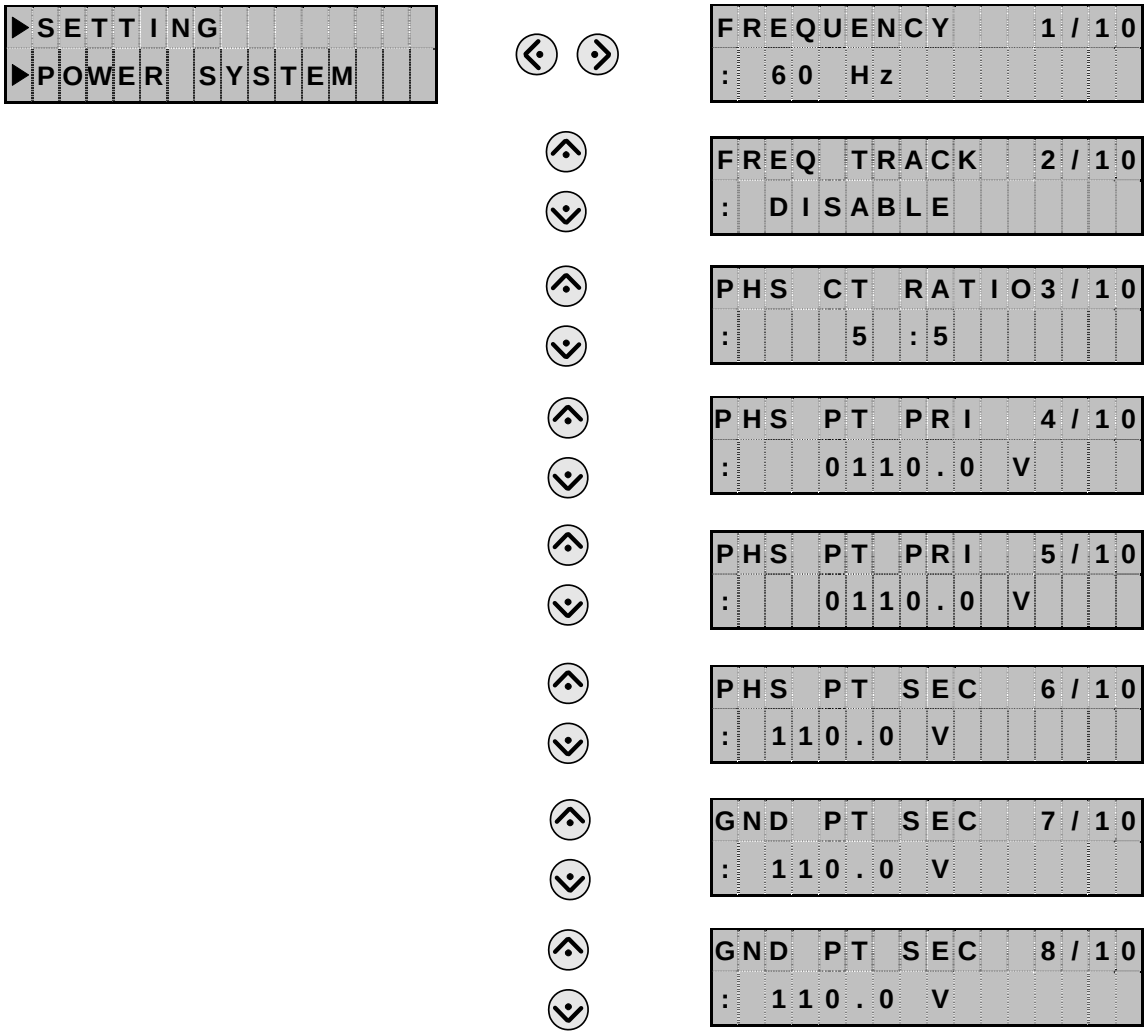
SYSTEM menu is composed of POWER SYSTEM, CB CONTROL, PT FUSE MONITOR, COM, DNP3.0, CONTACT INPUT, CONTACT OUTPUT, LED, and PASSWORD. POWER SYSTEM is used for setting of frequency, frequency tracking, phase CT ratio and ground CT. CB CONTROL is used for time setting TRIP and CLOSE PULSE. PT FUSE MONITOR is used for time of CB pulse setting. COM is used for communication setting. DNP3.0 is used for setting of DNP when communication method is DNP3.0. CONTACT INPUT / OUTPUT and LED are used for setting contact input/output and Programmable LED respectively. PASSWORD is used when change password.

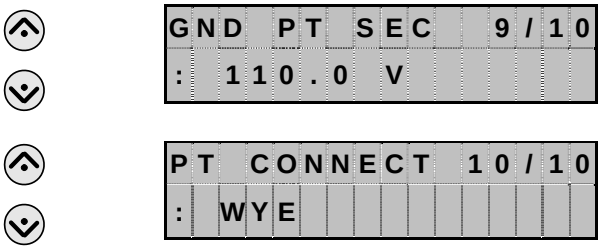




4.4.2.2. SETTING/SYSTEM/POWER SYSTEM

POWER SYSTEM is used for setting of frequency, frequency tracking, phase CT ratio, phase PT primary, phase PT secondary, ground PT primary, ground PT secondary and PT connect.



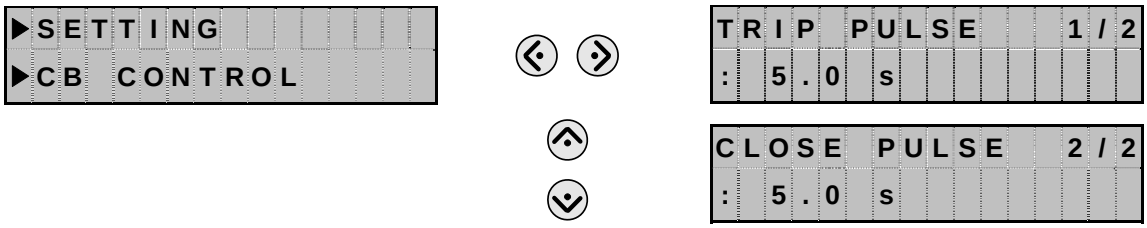


Item	Range	Setting unit	Basic value	Description
FREQUENCY	50Hz / 60Hz		60Hz	Frequency setting
FREQ TRACK	ENABLE/DISABLE		DISABLE	Frequency tracking setting
PHS CT RATIO	1 ~ 6000: 5	1	5	Phase CT ratio setting
PHS PT PRI	1 ~ 1000	1	0	Ground CT ratio setting
PHS PT PRI	0.0 ~ 999.9	0.1	110.0	Phase PT Primary setting
PHS PT SEC	50.0 ~ 250.0	0.1	110.0	Phase PT Secondary setting
GND PT PRI	0 ~ 1000	1	0	Ground PT Primary setting
GND PT PRI	0.0 ~ 999.9	0.1	110.0	Ground PT Primary setting
GND PT SEC	50.0 ~ 250.0	0.1	110.0	Ground PT Secondary setting
PT CONNECT	WYE / DELTA		WYE	PT connect setting

<Table 4.4.2.2. POWER SYSTEM Setting Item>

4.4.2.3. SETTING/SYSTEM/CB CONTROL

CB CONTROL is used for time setting TRIP and CLOSE PULSE.

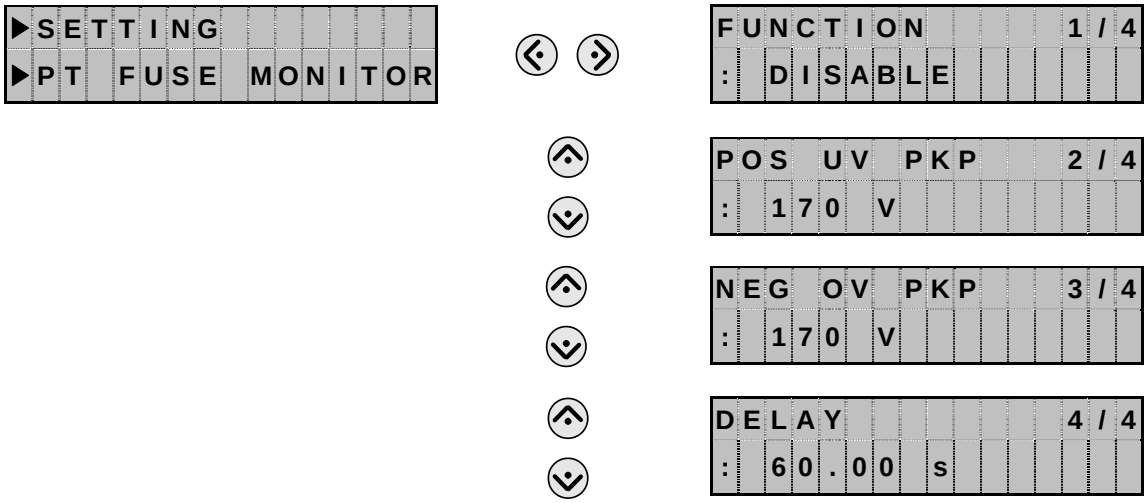


Item	Range	Setting unit	Basic value	Description
TRIP PULSE	0.1 ~ 5.0s	0.1s	5.0s	Time setting of CB Trip
CLOSE PULSE	0.1 ~ 5.0s	0.1s	5.0s	Time setting of CB Close

<Table 4.4.2.3. CB CONTROL Setting Item>

4.4.2.4. SETTING/SYSTEM/ PT FUSE MONITOR

PT FUSE MONITOR functions monitor of connecting transformer. FUSE MONITOR is composed of FUNCTION, POS UV PKP, NEG OV PKP and DELAY, used for setting of use or not of monitoring function, positive under voltage pickup, negative over voltage pickup and delay time of operation.

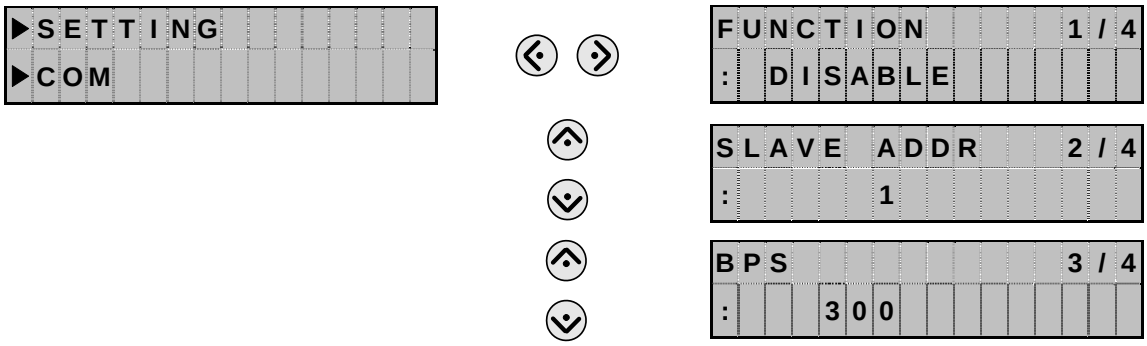


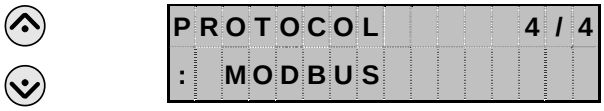
Item	Range	Setting unit	Basic value	Description
FUNCTION	ENABLE/DISABLE			Setting of use or not
POS UV PKP	5 ~ 170 V	1V	170V	Setting of positive under voltage pickup
NEG OV PKP	5 ~ 170 V	1V	170V	Setting of negative over voltage pickup
DELAY	0.00 ~ 60.00sec	0.01s	60.00sec	Delay time setting of operation

<Table 4.4.2.4. PT FUSE FAILURE MONITORING Setting Item >

4.4.2.5. SETTING/SYSTEM/COM

COM menu is composed of FUNCTION, SLAVE ADDR, BPS, and PROTOCOL and each menu set up communication function, slave address, BPS and protocol.



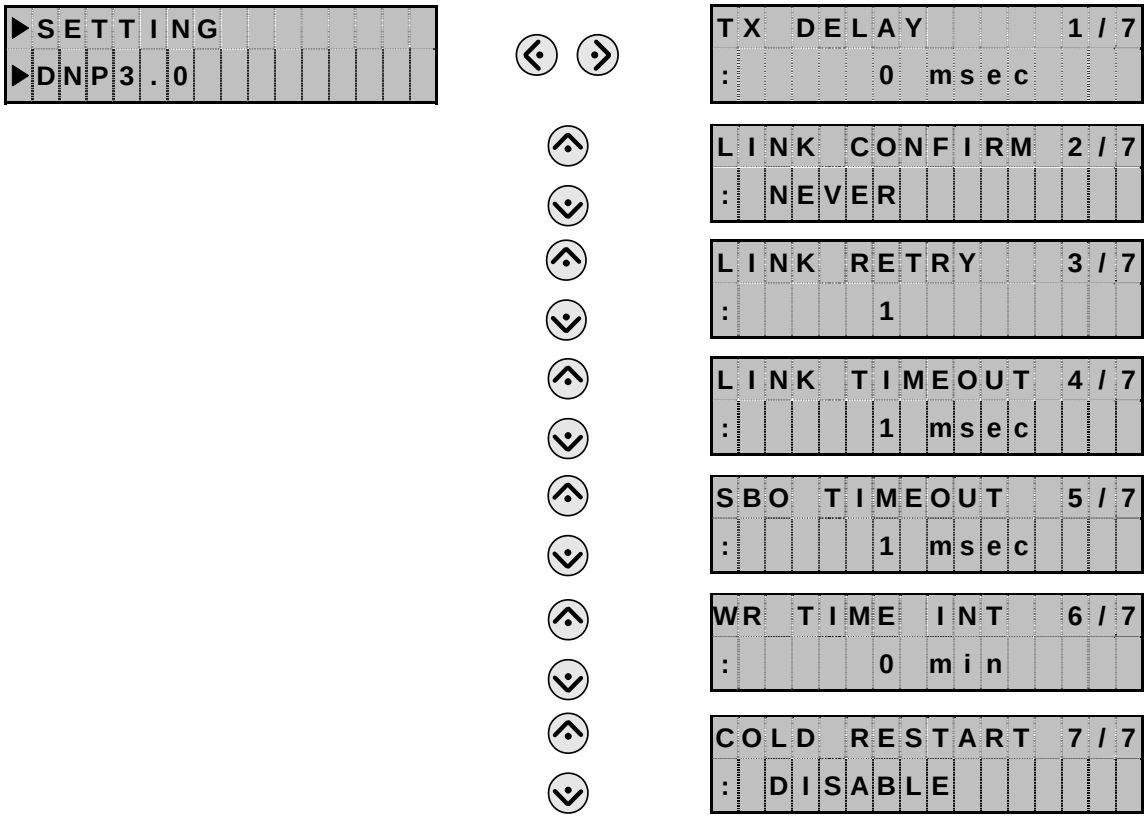


Item	Range	Setting unit	Basic value	Description
FUNCTION	ENABLE/DISABLE		DISABLE	Setting of use or not
SLAVE ADDR	1 ~ 65534	1	1	Slave address setting
BPS	300 ~ 38400		9600	Setting of communication speed
PROTOCOL	MODBUS/DNP3.0/IEC870		MODBUS	Protocol setting

<Table 4.4.2.5. COM Setting Item>

4.4.2.6. SETTING/SYSTEM/DNP3.0

DNP3.0 menu is composed of TX DELAY, LINK CONFIRM, LINK RETRY, LINK TIMEOUT, SBO TIMEOUT, WR TIME INT and COLD RESTART, and each menu set up Tx delay, Link confirm, Link retry, Link timeout, SBO timeout, Write time interval and Cold restart.



Item	Range	Setting unit	Basic value	Description
TX DELAY	0 ~ 65000msec	1msec	0msec	Tx delay setting
LINK CONFIRM	NEVER/ALWAYS /SOMETIMES		NEVER	Link confirm setting
LINK RETRY	0 ~ 5	1msec	0	Link retry setting
LINK TIMEOUT	1 ~ 65000msec	1msec	1msec	Link timeout setting
SBO TIMEOUT	1 ~ 65000msec	1msec	1msec	SBO timeout setting
WR TIME INT	0 ~ 65000min	1min	0min	Write time interval setting
COLD RESTART	ENABLE/DISABLE		DISABLE	Cold restart setting

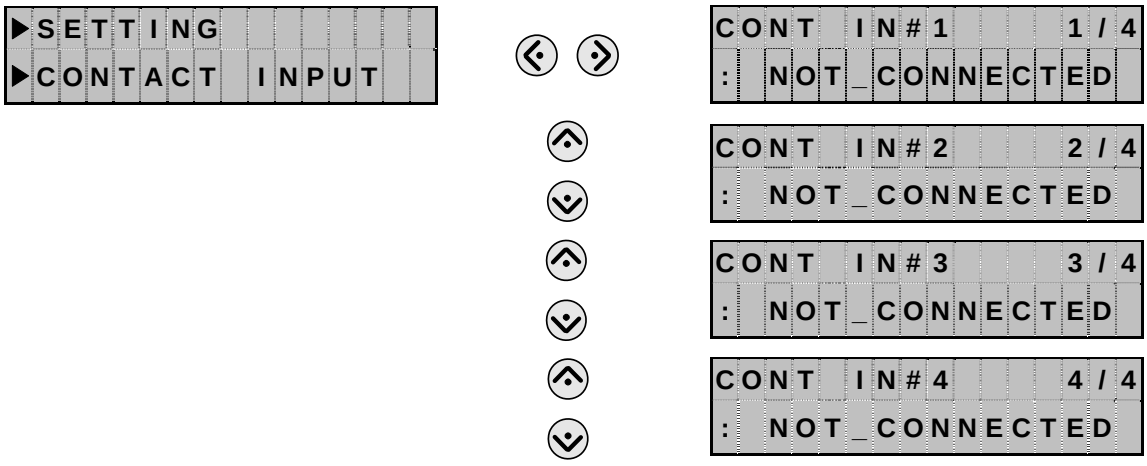
<Table 4.4.2.6. DNP3.0 Setting Item>

4.4.2.7. SETTING/SYSTEM/CONTACT INPUT

PAC-E500 has 4 Contact Input, it set each contact input "CONTACT INPUT".

There are NOT CONNECTED, CB OPENED, CB CLOSED, ANNUN RESET, PROT BLOCK and GENERAL INPUT in setting value of CONTACT INPUT.

That CB may control, only if one or more contact inputs are allocated for CB Open/Closed status. In that case, CB is controlled the fastest contact input.



Item	Range	Setting unit	Basic value	Description
CONT IN #1~#4	NOT_CONNECTED/ CB_OPENED/ CB_CLOSED/ ANNUN_RESET/ PROT_BLOCK/ GENERAL_INPUT		NOT_CONNECTED	Setting of contact input

<Table 4.4.2.7.1. CONTACT INPUT Setting Item>

Contact Input elements	Description
NOT_CONNECTED	No effect
CB_OPENED	Open CB, when input is logic "1".
CB_CLOSED	Close CB, when input is logic "1"
ANNUN_RESET	Operate Annunciator Reset, if there is status change of Input Logic.
PROT_BLOCK	Do action that protection element make BLOCK, when input is logic "1" and BLOCK of protection element is "Yes".
GENERAL_INPUT	Used general Contact Input

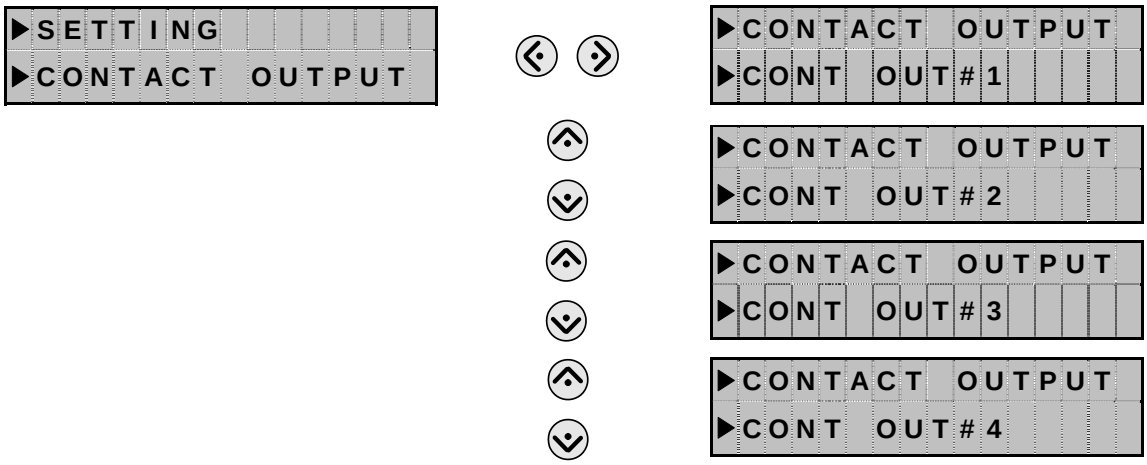
<Table 4.4.2.7.2. CONTACT INPUT Setting elements>

4.4.2.8. SETTING/SYSTEM/CONTACT OUTPUT

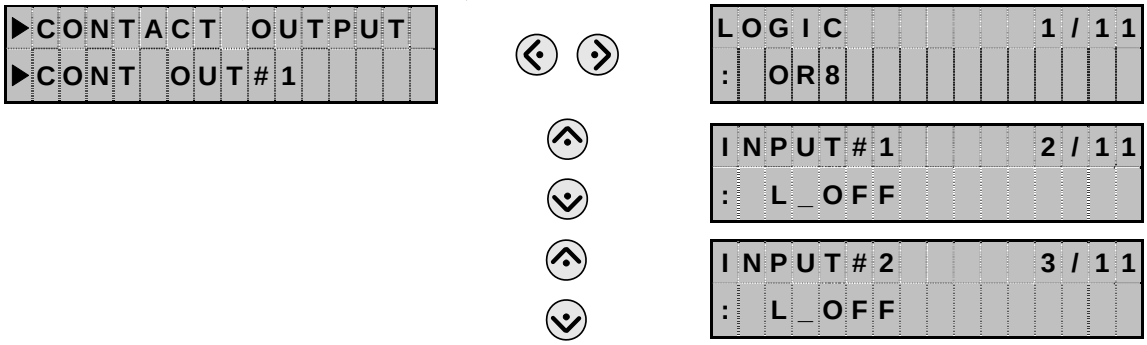
PAC-E500 has 4 Contact output and Contact output is set at "CONTACT OUTPUT". There are LOGIC, 8 INPUT, RESET TYPE and RESET DELAY in setting value of Contact Output가 있습니다.

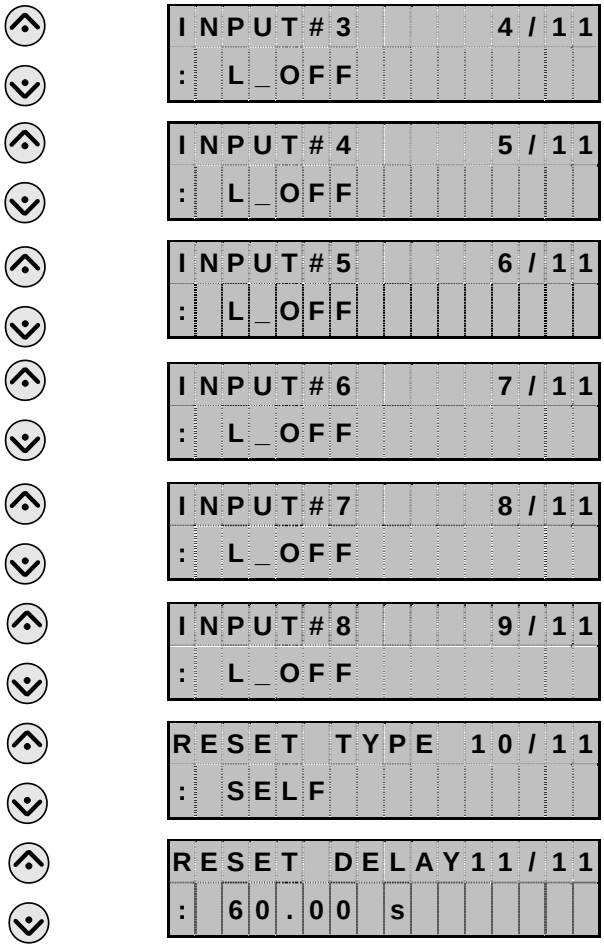
Setting factor of LOGIC has OR8 and AND8 that are composed 8 Non-Inverting Input, and HALF-OR8 and HALF-AND8 that are composed 4 Non Inverting Input and 4 Inverting Input.

Setting Factor of INPUT has System status, Contact Input/Output status and Operating status protection element, and RESET TYPE has two setting items; 1) SELF with RESET DELAY time and 2) MANUAL of LATCH type. RESET DELAY has Off Reset Delay time between 0.00sec ~ 60.00sec.



- CONTACT OUT (CONT OUT#1 ~ 4)



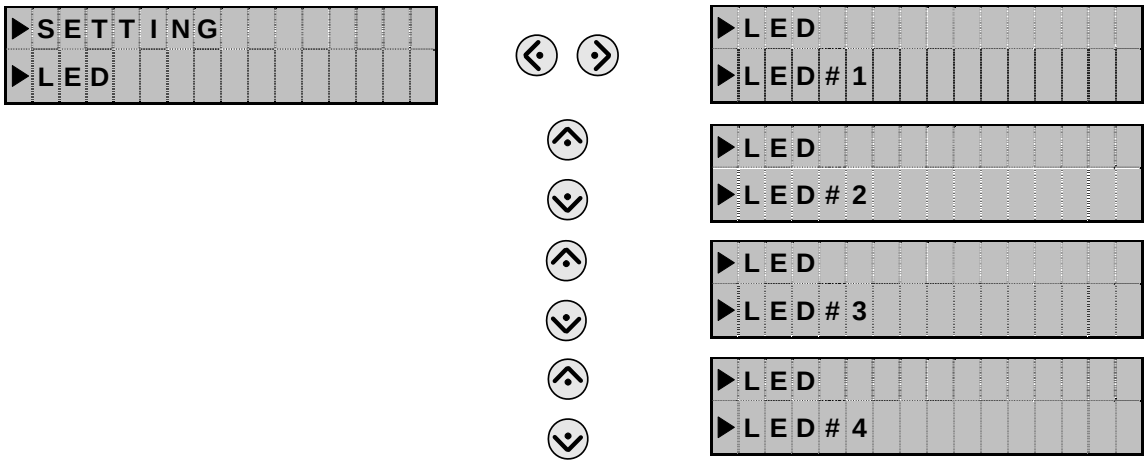


Item	Range	Setting unit	Basic value	Description
LOGIC	OR8/HALF-OR8/ AND8/HALF-AND8		OR8	Operator setting
INPUT #1~#8	Refer to Table 3.2.3.3.			Input setting of Operator
RESET TYPE	SELF/MANUAL			Form of Contact Output setting
RESET DELAY	0.00 ~ 60.00sec	0.01sec	0.00sec	Off delay setting (Activated when RESET TYPE is "SELF")

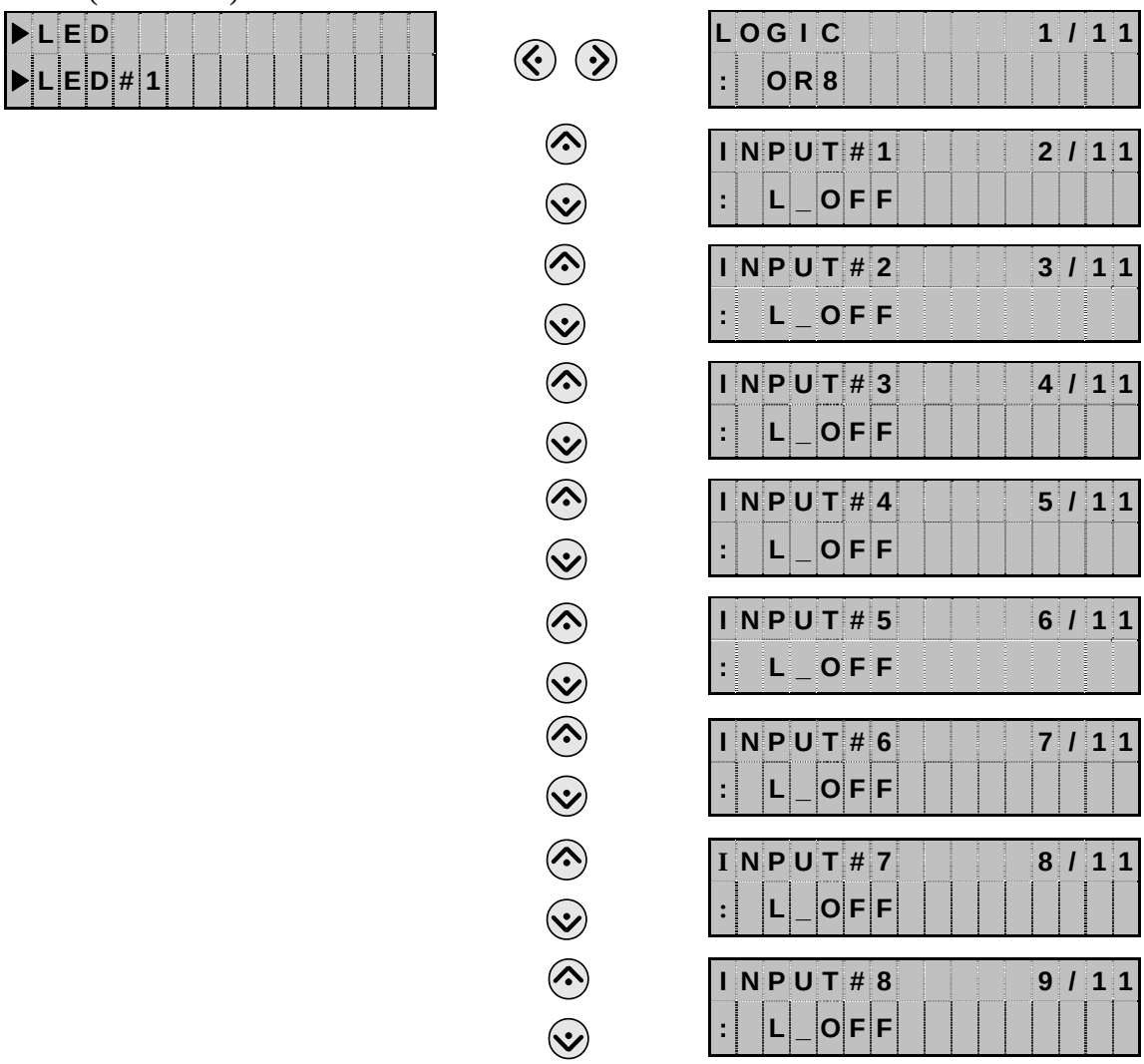
<Table 4.4.2.8. CONTACT OUTPUT Setting Item>

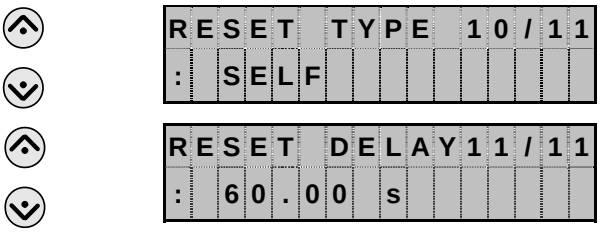
4.4.2.9. SETTING/SYSTEM/LED

PAC-E500 provides 4 Programmable LED for the convenience of user. The setting method is same with CONTACT OUTPUT.



- LED (LED#1 ~ 4)



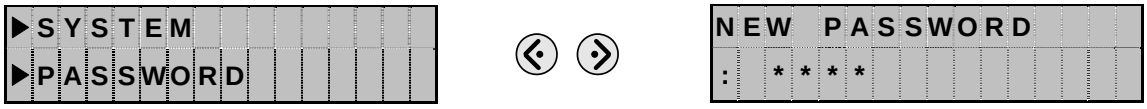


Item	Range	Setting unit	Basic value	Description
LOGIC	OR8/HALF-OR8/ AND8/HALF-AND8		OR8	Operator setting
INPUT #1~#8	Reference Table 3.2.3.3.			Input setting of Operator
RESET TYPE	SELF/MANUAL			Form of Contact Output setting
RESET DELAY	0.00 ~ 60.00sec	0.01sec	0.00sec	Off delay setting (Activated when RESET TYPE is "SELF")

<Table 4.4.2.9. LED Setting Item>

4.4.2.10. SETTING/SYSTEM/PASSWORD

There are 2 types of passwords for PAC-E500: Settings modification password and Control action password. Both passwords are same and 4-digit decimal 0~9 numbers and have the initial values of "0000" on delivery of PAC-E500.

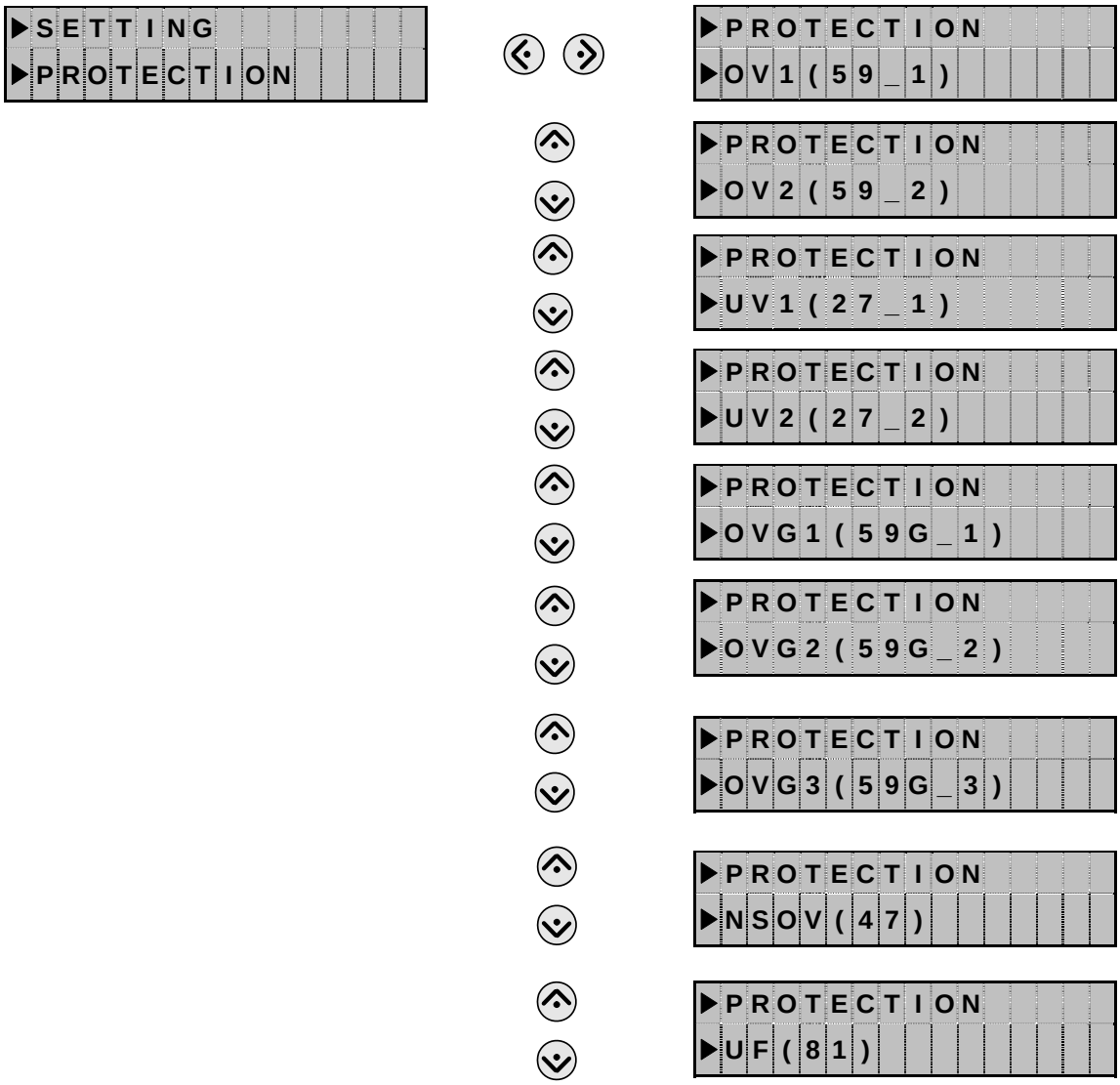


[PASSWORDS setting steps]

1) Right arrow key from PASSWORDS menu in Menu Tree
2) Select which password to change using Up/Down keys and Right key
3) Enter original settings modification password if required
4) Change or select each of 4 digit values using arrow keys and ENT key
5) Save setting changes in escaping SETTING menu or Change other values

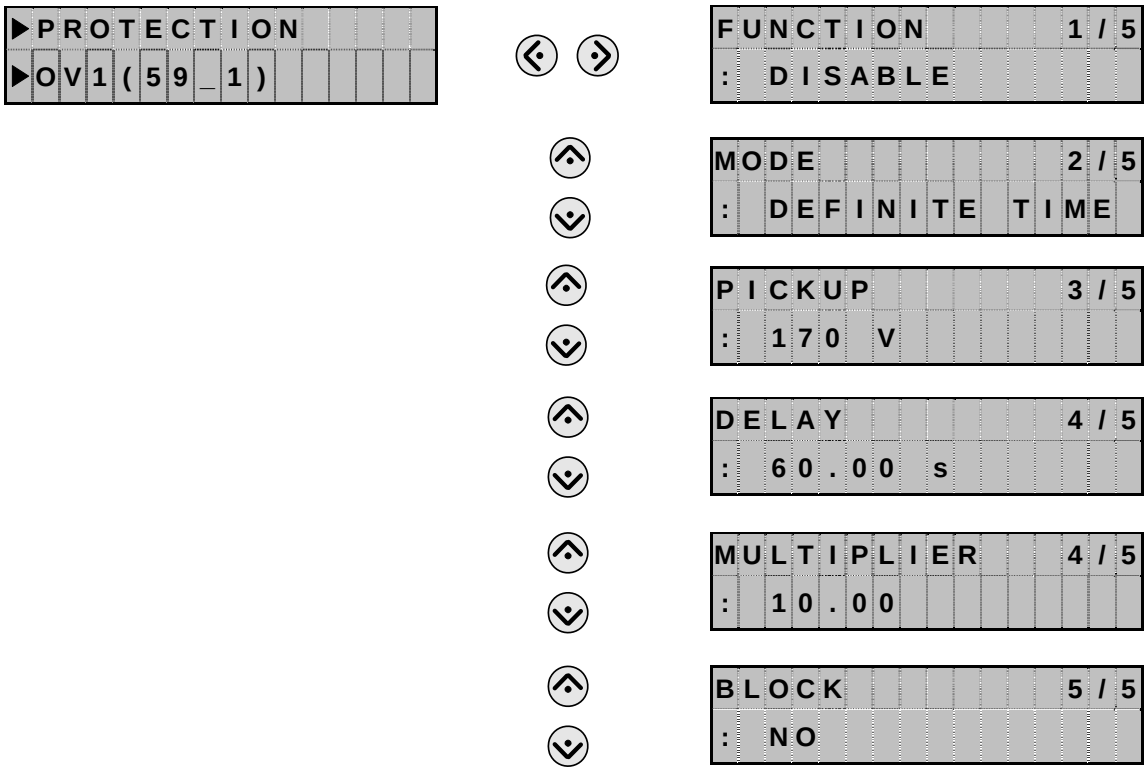
4.4.2.11. SETTING/PROTECTION

PROTECTION menu is composed of protection elements, OV1 (59_1), OV2 (59_2), UV1 (27_1), UV2 (27_1), OVG1 (59G_1), OVG2 (59G_2), OVG3 (59G_3), NSOV (47) and UF (81), and is used setting each of protection elements.



4.4.2.12. SETTING/PROTECTION/OV1 (59_1)

OV1 (59_1) is Over Voltage protection including Definite Time-delayed. It operates Definite Time characteristic, when 'MODE' is 'DEFINITE TIME', and operates voltage Inverse Time Delayed characteristic, when 'MODE' is 'INVERSE CURVE'.

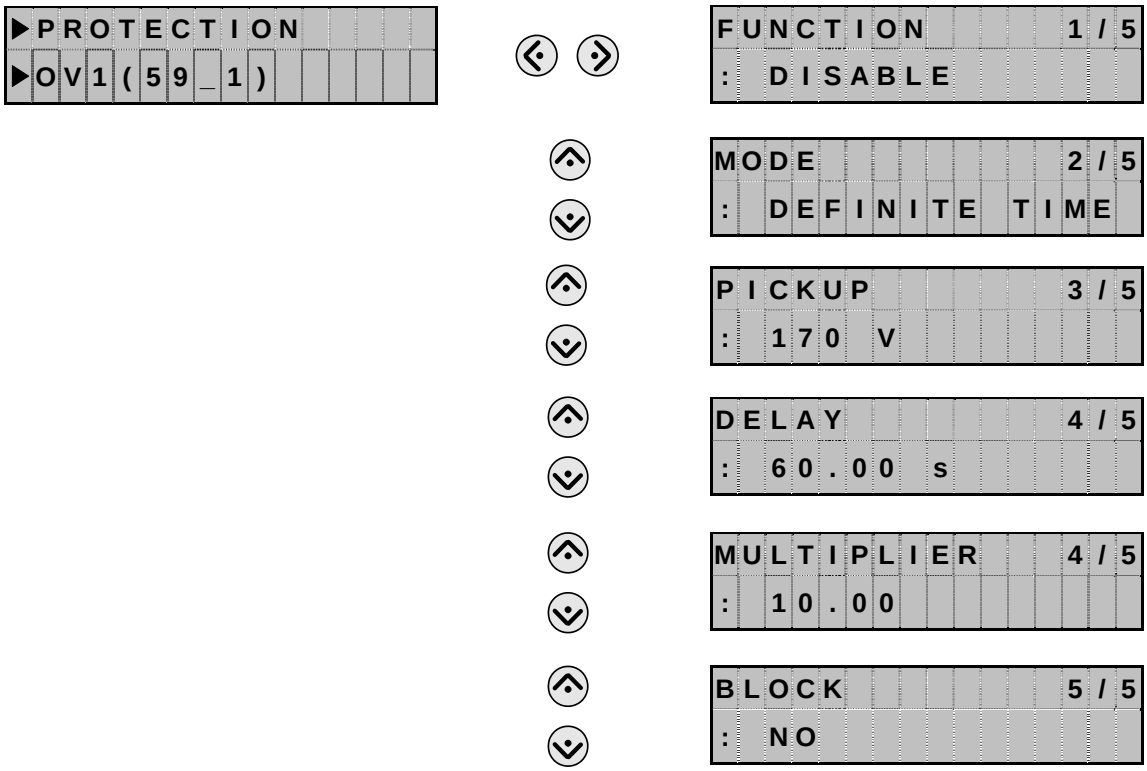


Item	Range	Setting unit	Basic value	Description
FUNCTION	ENABLE/DISABLE		DISABLE	Protection Elements setting
MODE	DEFINITE TIME / INVERSE CURVE		DEFINITE TIME	Operation Mode setting
PICKUP	5~170V	1V	170V	Pickup setting
DELAY	0.00 ~ 60.00sec	0.01sec	0.00sec	Operation delay time setting (Setting when 'Mode' is 'Definite Time')
MULTIPLIER	0.01 ~ 10.00	0.01	10.00	Multiplier setting (Setting when 'Mode' is 'Inverse Curve')
BLOCK	YES/NO		NO	Ban protection function It is set PROT_BLOCK of Contact Input, and banned protection function when Contact input status is Logic "1".

<Table 4.4.2.12. OVG1 (59_1) Setting Item>

4.4.2.13. SETTING/PROTECTION/OV2 (59_2)

OV2 (59_2) is Over Voltage protection including Definite Time-delayed. It operates Definite Time characteristic, when 'MODE' is 'DEFINITE TIME', and operates voltage Inverse Time Delayed characteristic, when 'MODE' is 'INVERSE CURVE'.

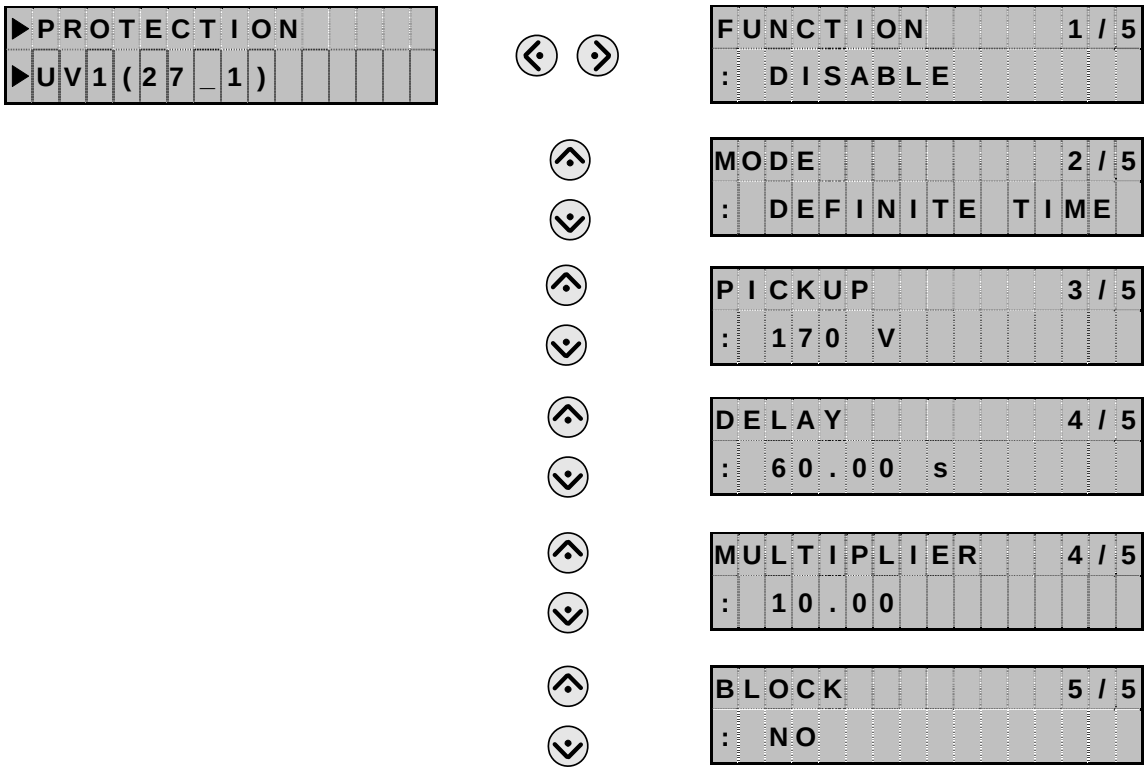


Item	Range	Setting unit	Basic value	Description
FUNCTION	ENABLE/DISABLE		DISABLE	Protection Elements setting
MODE	DEFINITE TIME / INVERSE CURVE		DEFINITE TIME	Operation Mode setting
PICKUP	5~170V	1V	170V	Pickup setting
DELAY	0.00 ~ 60.00sec	0.01sec	0.00sec	Operation delay time setting (Setting when 'Mode' is 'Definite Time')
MULTIPLIER	0.01 ~ 10.00	0.01	10.00	Multiplier setting (Setting when 'Mode' is 'Inverse Curve')
BLOCK	YES/NO		NO	Ban protection function It is set PROT_BLOCK of Contact Input, and banned protection function when Contact input status is Logic "1".

<Table 4.4.2.13. OVG2 (59_2) Setting Item>

4.4.2.14. SETTING/PROTECTION/UV1 (27_1)

UV1 (27_1) is Over Voltage protection including Definite Time-delayed. It operates Definite Time characteristic, when 'MODE' is 'DEFINITE TIME', and operates voltage Inverse Time Delayed characteristic, when 'MODE' is 'INVERSE CURVE'.

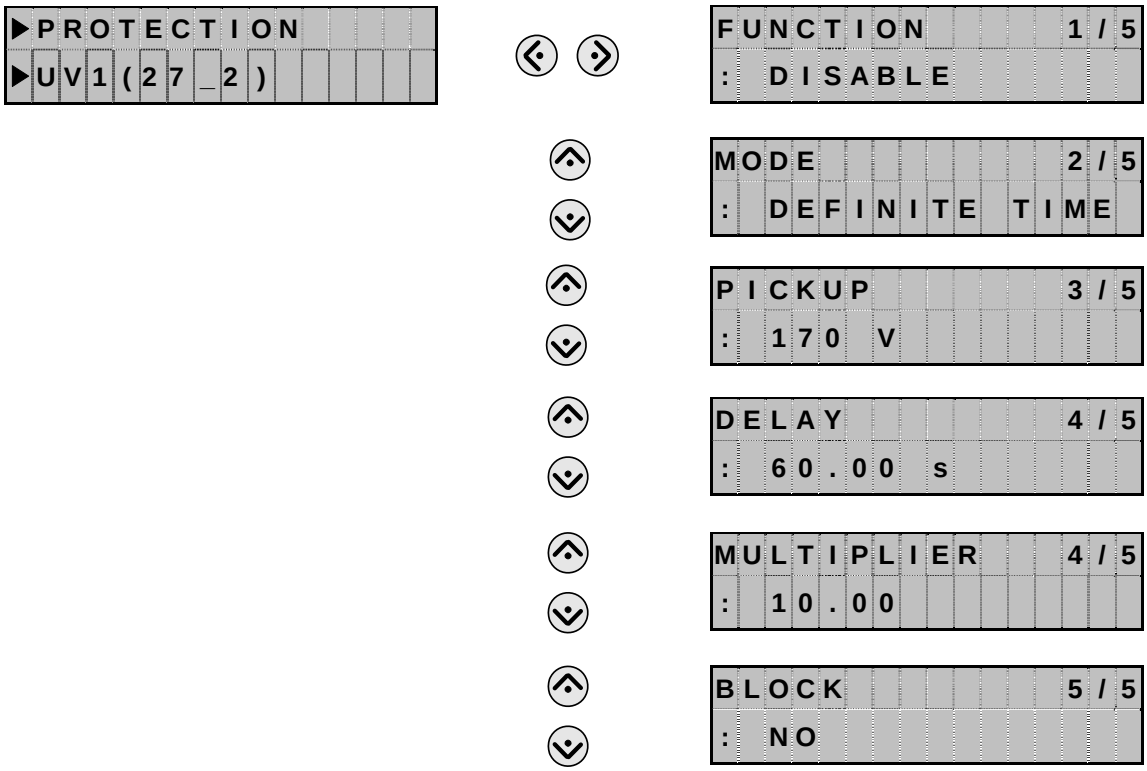


Item	Range	Setting unit	Basic value	Description
FUNCTION	ENABLE/DISABLE		DISABLE	Protection Elements setting
MODE	DEFINITE TIME / INVERSE CURVE		DEFINITE TIME	Operation Mode setting
PICKUP	5~170V	1V	170V	Pickup setting
DELAY	0.00 ~ 60.00sec	0.01sec	0.00sec	Operation delay time setting (Setting when 'Mode' is 'Definite Time')
MULTIPLIER	0.01 ~ 10.00	0.01	10.00	Multiplier setting (Setting when 'Mode' is 'Inverse Curve')
BLOCK	YES/NO		NO	Ban protection function It is set PROT_BLOCK of Contact Input, and banned protection function when Contact input status is Logic "1".

<Table 4.4.2.14. UV1 (27_1) Setting Item>

4.4.2.15. SETTING/PROTECTION/UV2 (27_2)

UV1 (27_2) is Over Voltage protection including Definite Time-delayed. It operates Definite Time characteristic, when 'MODE' is 'DEFINITE TIME', and operates voltage Inverse Time Delayed characteristic, when 'MODE' is 'INVERSE CURVE'.

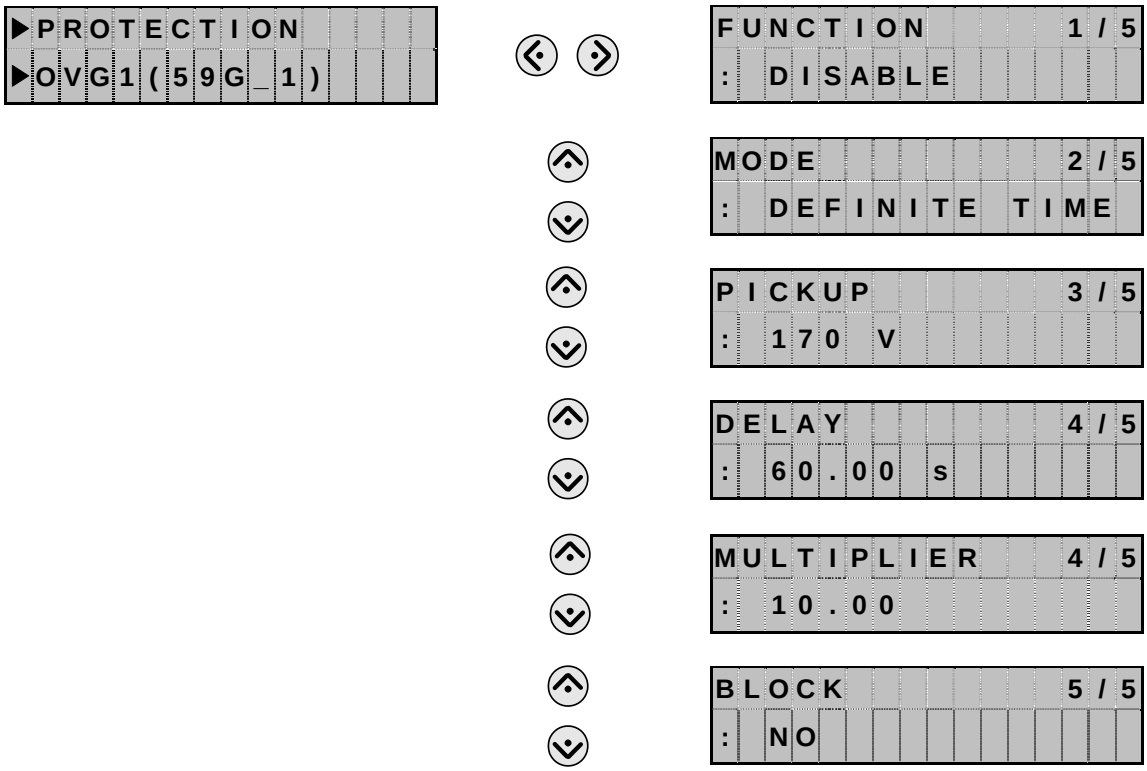


Item	Range	Setting unit	Basic value	Description
FUNCTION	ENABLE/DISABLE		DISABLE	Protection Elements setting
MODE	DEFINITE TIME / INVERSE CURVE		DEFINITE TIME	Operation Mode setting
PICKUP	5~170V	1V	170V	Pickup setting
DELAY	0.00 ~ 60.00sec	0.01sec	0.00sec	Operation delay time setting (Setting when 'Mode' is 'Definite Time')
MULTIPLIER	0.01 ~ 10.00	0.01	10.00	Multiplier setting (Setting when 'Mode' is 'Inverse Curve')
BLOCK	YES/NO		NO	Ban protection function It is set PROT_BLOCK of Contact Input, and banned protection function when Contact input status is Logic "1".

<Table 4.4.2.15. UV2 (27_2) Setting Item>

4.4.2.16. SETTING/PROTECTION/OVG1 (59G_1)

OVG1 (59G_1) is Ground Over Voltage protection including Definite Time-delayed. It operates Definite Time characteristic, when 'MODE' is 'DEFINITE TIME', and operates voltage Inverse Time Delayed characteristic, when 'MODE' is 'INVERSE TRIP' or 'INVERSE ALARM' in accordance with each time characteristic curve.

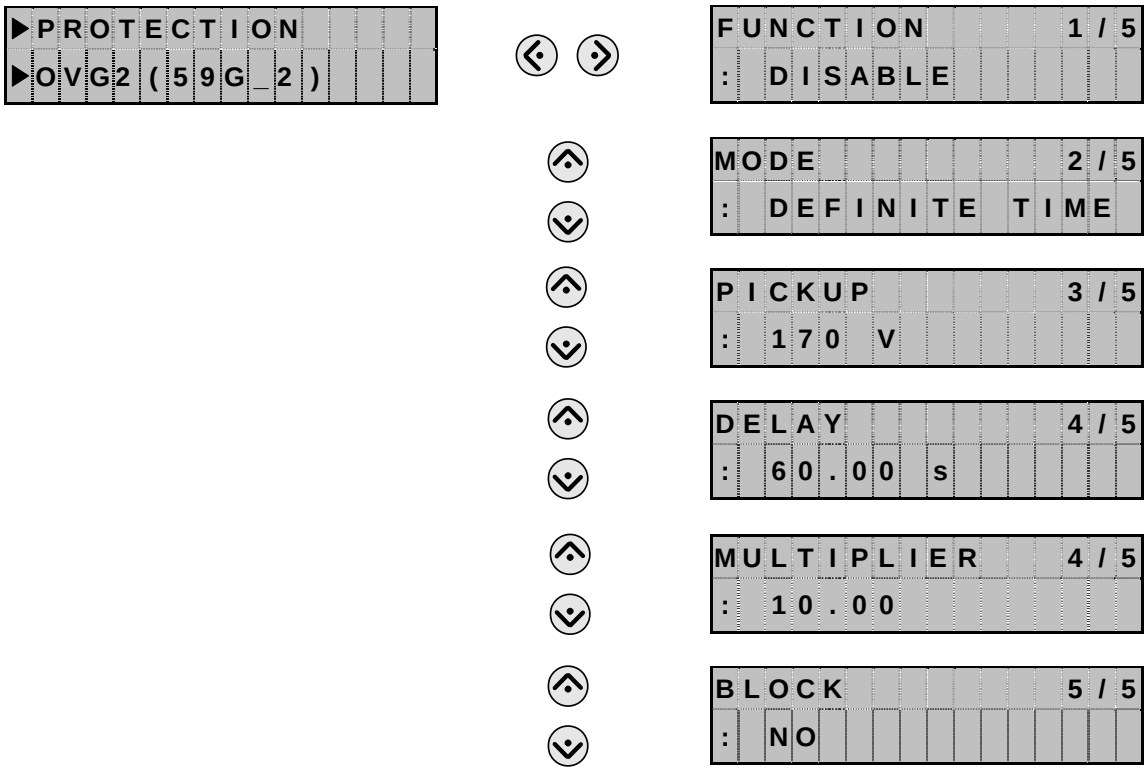


Item	Range	Setting unit	Basic value	Description
FUNCTION	ENABLE/DISABLE		DISABLE	Protection Elements setting
MODE	DEFINITE TIME / INVERSE CURVE		DEFINITE TIME	Operation Mode setting
PICKUP	5~170V	1V	170V	Pickup setting
DELAY	0.00 ~ 60.00sec	0.01sec	0.00sec	Operation delay time setting (Setting when 'Mode' is 'Definite Time')
MULTIPLIER	0.01 ~ 10.00	0.01	10.00	Multiplier setting (Setting when 'Mode' is 'Inverse Curve')
BLOCK	YES/NO		NO	Ban protection function It is set PROT_BLOCK of Contact Input, and banned protection function when Contact input status is Logic "1".

<Table 4.4.2.16.OVG1 (59G_1) Setting Item>

4.4.2.17. SETTING/PROTECTION/OVG2 (59G_2)

OVG2 (59G_2) is Ground Over Voltage protection including Definite Time-delayed. It operates Definite Time characteristic, when 'MODE' is 'DEFINITE TIME', and operates voltage Inverse Time Delayed characteristic, when 'MODE' is 'INVERSE TRIP' or 'INVERSE ALARM' in accordance with each time characteristic curve.

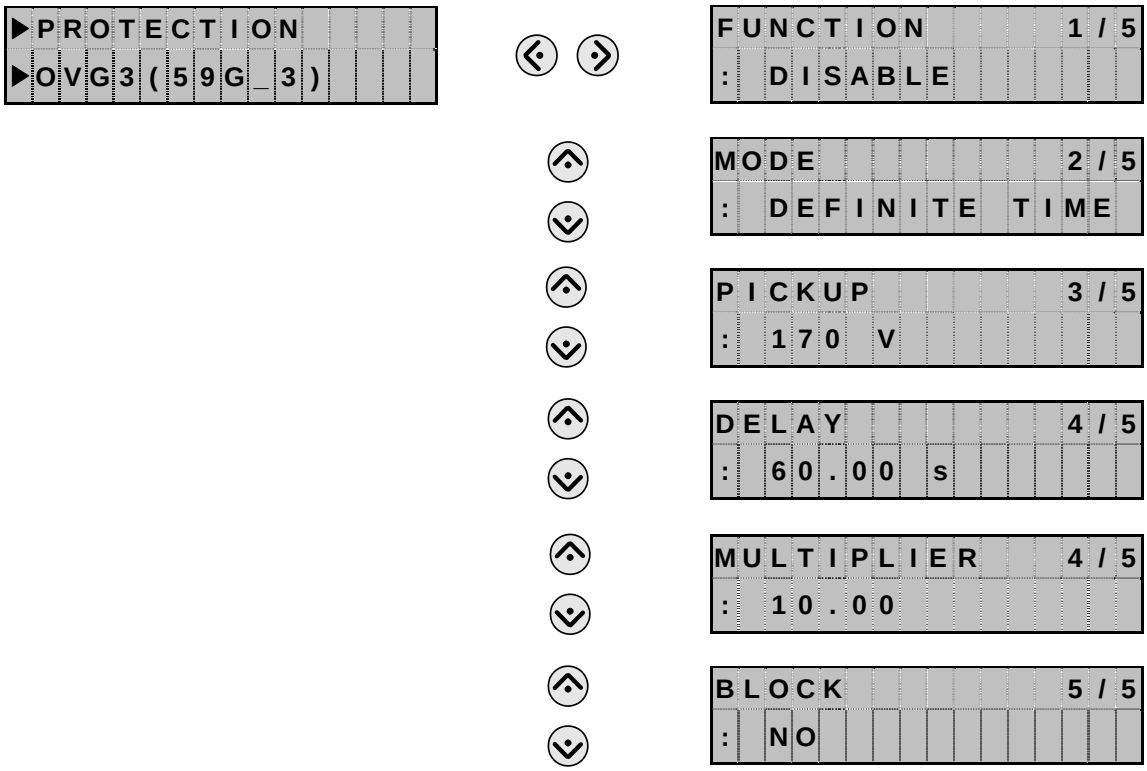


Item	Range	Setting unit	Basic value	Description
FUNCTION	ENABLE/DISABLE		DISABLE	Protection Elements setting
MODE	DEFINITE TIME / INVERSE CURVE		DEFINITE TIME	Operation Mode setting
PICKUP	5~170V	1V	170V	Pickup setting
DELAY	0.00 ~ 60.00sec	0.01sec	0.00sec	Operation delay time setting (Setting when 'Mode' is 'Definite Time')
MULTIPLIER	0.01 ~ 10.00	0.01	10.00	Multiplier setting (Setting when 'Mode' is 'Inverse Curve')
BLOCK	YES/NO		NO	Ban protection function It is set PROT_BLOCK of Contact Input, and banned protection function when Contact input status is Logic "1".

<Table 4.4.2.17.OVG2 (59G_2) Setting Item>

4.4.2.18. SETTING/PROTECTION/OVG3 (59G_3)

OVG3 (59G_3) is Ground Over Voltage protection including Definite Time-delayed. It operates Definite Time characteristic, when 'MODE' is 'DEFINITE TIME', and operates voltage Inverse Time Delayed characteristic, when 'MODE' is 'INVERSE TRIP' or 'INVERSE ALARM' in accordance with each time characteristic curve.

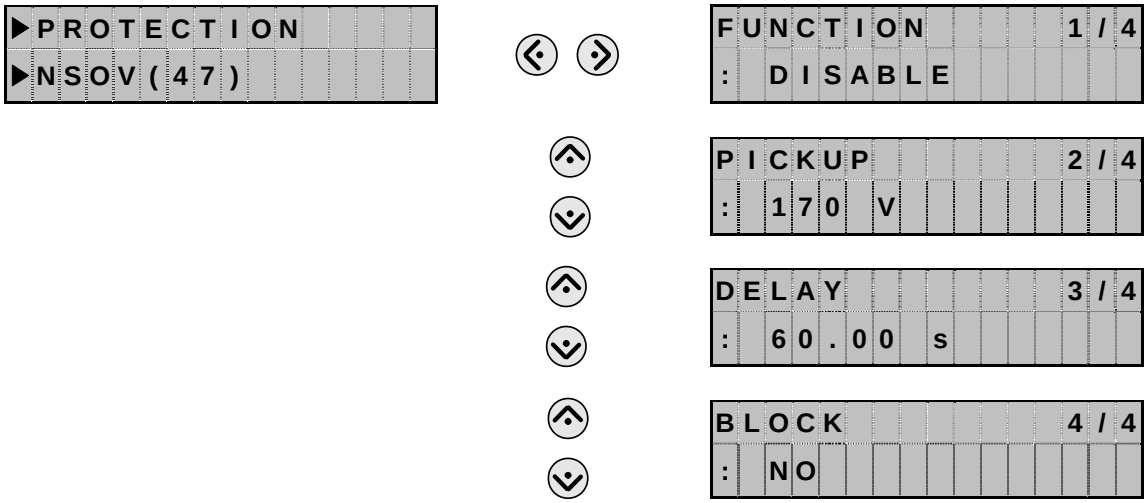


Item	Range	Setting unit	Basic value	Description
FUNCTION	ENABLE/DISABLE		DISABLE	Protection Elements setting
MODE	DEFINITE TIME / INVERSE CURVE		DEFINITE TIME	Operation Mode setting
PICKUP	5~170V	1V	170V	Pickup setting
DELAY	0.00 ~ 60.00sec	0.01sec	0.00sec	Operation delay time setting (Setting when 'Mode' is 'Definite Time')
MULTIPLIER	0.01 ~ 10.00	0.01	10.00	Multiplier setting (Setting when 'Mode' is 'Inverse Curve')
BLOCK	YES/NO		NO	Ban protection function It is set PROT_BLOCK of Contact Input, and banned protection function when Contact input status is Logic "1".

<Table 4.4.2.18.OVG3 (59G_3) Setting Item>

4.4.2.19. SETTING/PROTECTION/NSOV (47)

NSOV (47) is Negative Sequence Phase Over Voltage protection. In case of the negative phase voltage higher than pick-up, it operates Definite Time characteristic that has operate time.

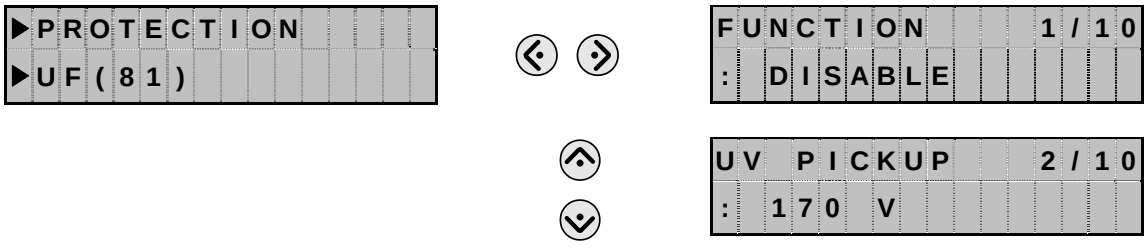


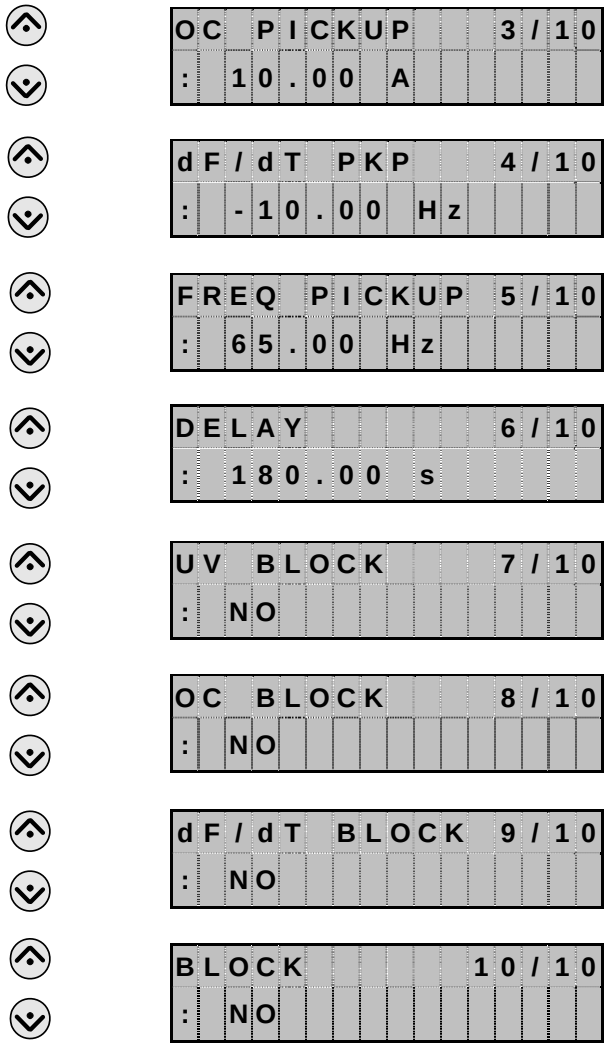
Item	Range	Setting unit	Basic value	Description
FUNCTION	ENABLE/DISABLE		DISABLE	Protection Elements setting
PICKUP	5~170V	1V	170V	Pickup setting
DELAY	0.00 ~ 60.00sec	0.01sec	0.00sec	Operation delay time setting (Setting when 'Mode' is 'Definite Time')
BLOCK	YES/NO		NO	Ban protection function It is set PROT_BLOCK of Contact Input, and banned protection function when Contact input status is Logic "1".

<Table 4.4.2.19.NSOV (47) Setting Item>

4.4.2.20. SETTING/PROTECTION/UF (81)

UF (81) is Under Frequency protection. In case of the frequency of A-phase voltage lower than FREQ PICKUP, it operates and requisite fault detection is added when each 'Block' element is set. Voltage is input lower than 'UV PICKUP' when UV PICKUP is set and in case of under frequency the protection element doesn't operate blocked. And 'OC BLOCK' and 'dF/dT BLOCK' operate in the same way.



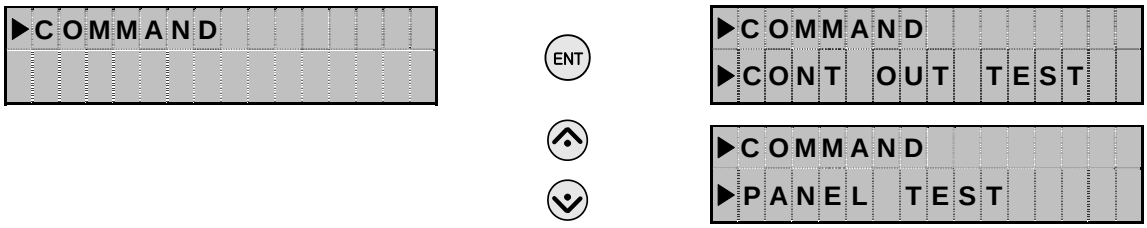


Item	Range	Setting unit	Basic value	Description
FUNCTION	ENABLE/DISABLE		DISABLE	Protection Elements setting
UV PICKUP	5~170V	1V	170V	Under Voltage Pickup setting
OC PICKUP	0.10 ~ 20.00*In	0.01*In	20.00*In	Over Current Pickup setting
dF/dT PKP	-10.00 ~ -0.10Hz	0.01Hz	-10.00Hz	Transient frequency Pickup setting
FREQ PICKUP	45.00 ~ 65.00Hz	0.01Hz	59.00Hz	Frequency Pickup setting
DELAY	0.00 ~ 180.00sec	0.01sec	180.00sec	Operation delay time setting
UV BLOCK	YES/NO		NO	Under Voltage Block setting
OC BLOCK	YES/NO		NO	Over Current Block setting
dF/dT BLOCK	YES/NO		NO	Transient frequency Block setting
BLOCK	YES/NO		NO	Ban protection function It is set PROT_BLOCK of Contact Input, and banned protection function when Contact input status is Logic "1".

4.4.3 COMMAND Menu

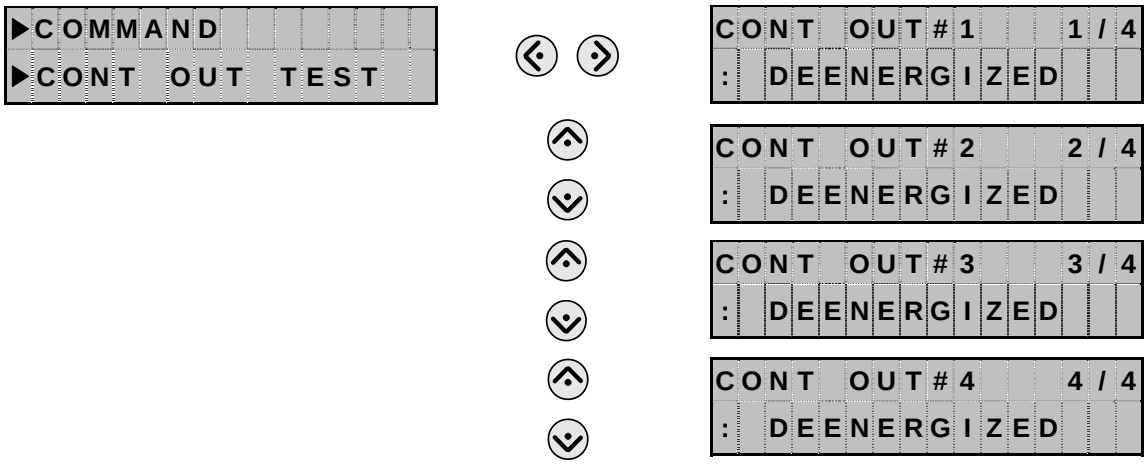
<Table 4.4.2.20. UF (81) Setting Item>

COMMAND menu is composed of CONT OUT TEST and PANEL TEST sub menus. This menu is used to test output contacts and LCD/LEDs of front-face display panel. All the submenus are required to enter the password.



4.4.3.1. COMMAND/CONT OUT TEST

CONT OUT TEST command is used to test contact outputs individually.



[CONT OUT TEST command steps]

1) Right arrow key from CONT OUT TEST menu in Menu Tree
2) Select test item of 16 contact outputs using Up/Down key and Right key
3) Enter settings modification password if required
4) Execute Energized or DeEnergized test using Up/Down key
   "Run/Test" LED blinking green or Error message
5) Left key to escape and Repeat steps 2~4 for other items

4.4.3.2. COMMAND/PANEL TEST

PANEL TEST command is used to test LCD and LEDs on front-face display panel.

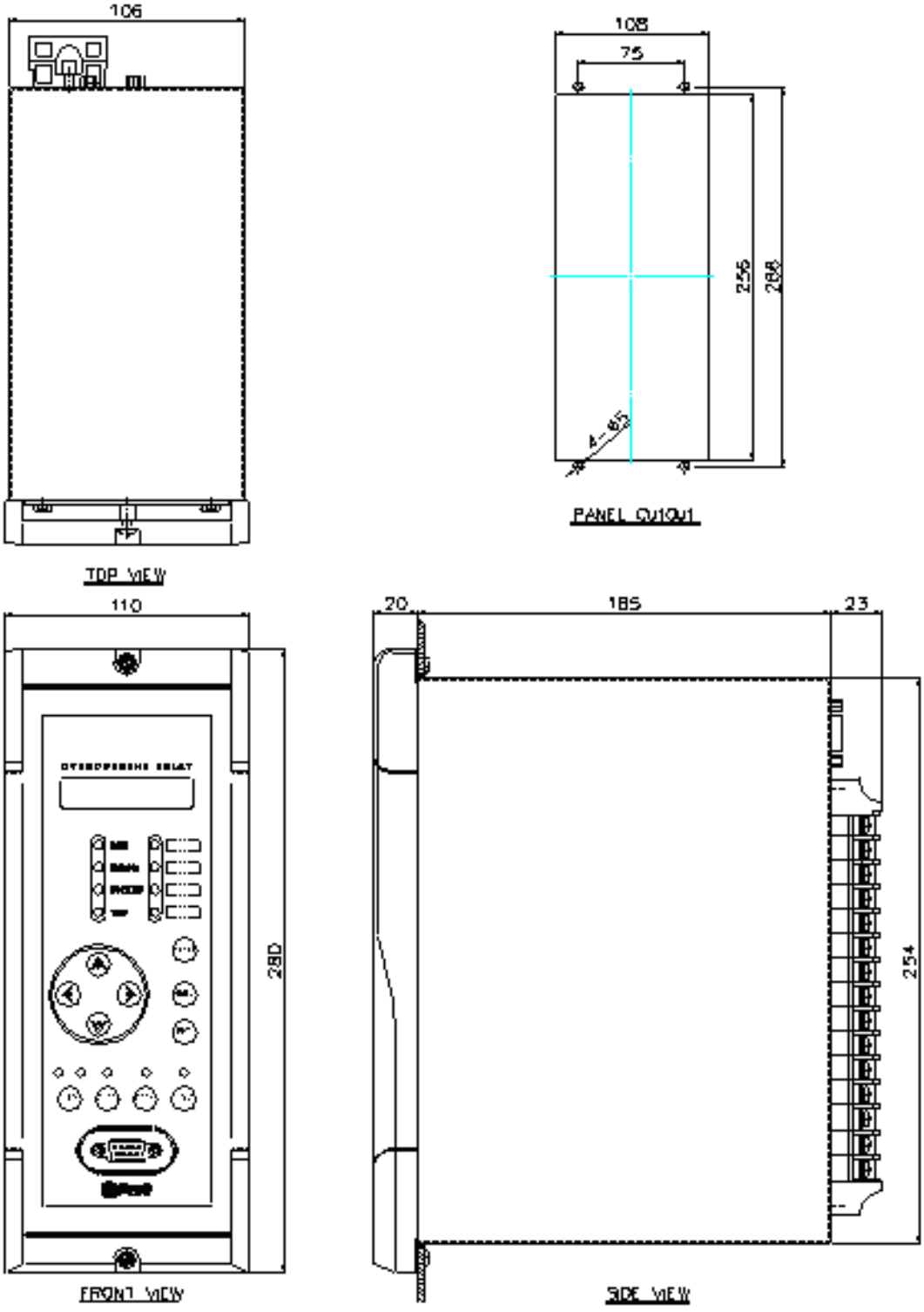
[PANEL TEST command steps]

1) Right arrow key from PANEL TEST menu in Menu Tree
2) Enter settings modification password and Right arrow key again
3) LCD and all LEDs blinking or Error message, and Return to Menu Tree

5 Dimensions and External Connections

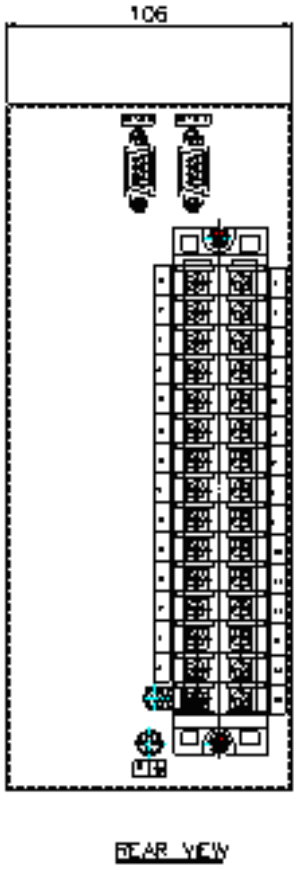
PAC-E500 is designed as draw-out type, and external connection, installation, and maintenance are easily managed.

5.1 DIMENSIONED DRAWINGS



<Figure 5.1 Dimensioned Drawings of PAC-E500>

5.1. Terminal Block Diagram



<Figure 5.2 Terminal Block Diagram of PAC-E500>

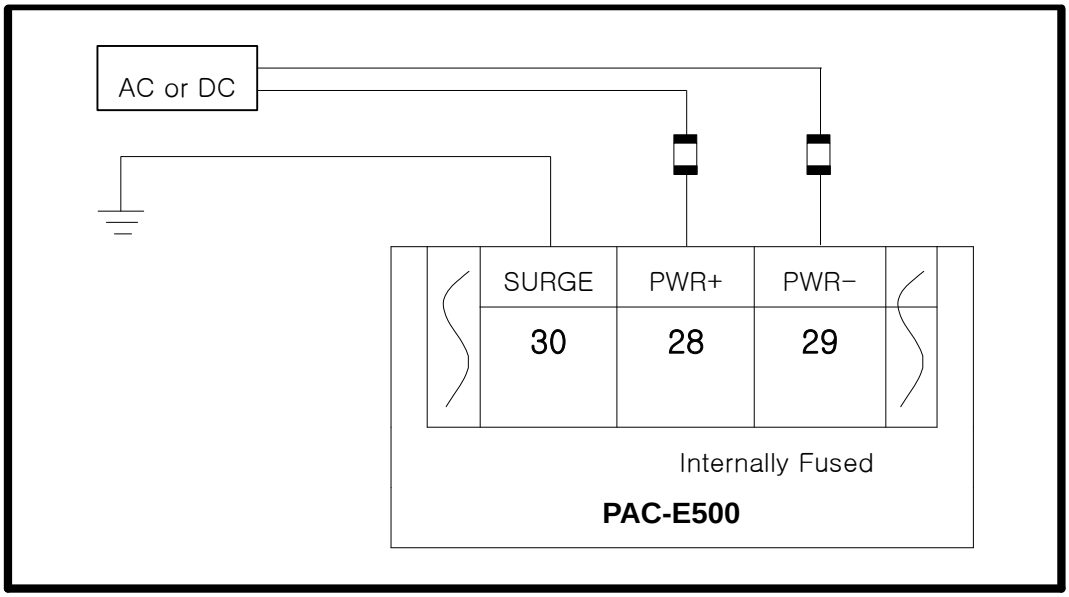
PAC-E500			
No	Description	No	Description
16	IA+	1	IA-
17	VA+	2	VA-
18	VB+	3	VB-
19	VC+	4	VC-
20	VN+	5	VN-
21	TS1_COM	6	TS1_NO
22	TS2_COM	7	TS2_NO
23	TS3_COM	8	TS3_NO
24	TS4_COM	9	TS3_NC
25	TS4_NC	10	TS4_NO
26	DI1_COM	11	DI1_P
27	DI2_COM	12	DI2_P
28	PWR+	13	DI3_P
29	PWR-	14	DI4_P
30	FG	15	DI3_4_COM

<Table 5.2 Terminal Block Diagram Table>

5.2 EXTERNAL CONNECTIONS

5.2.1 Control Source

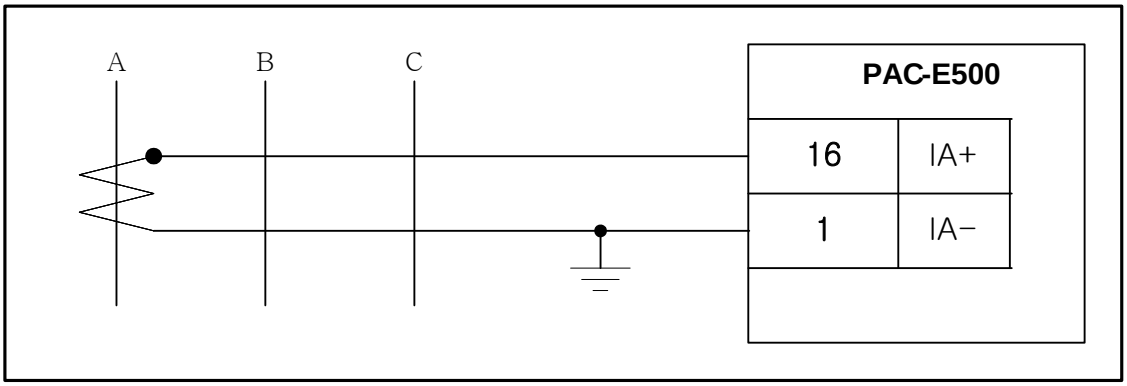
Control source or Energizing input to PAC-E500 necessitates validation between the permitted ranges. If the control source is connected to other than control source terminal, protection units and internal circuits are damaged.



<Figure 5.3.1 Control Source Terminal Connection of PAC-E500 >

5.2.2 CT Connections

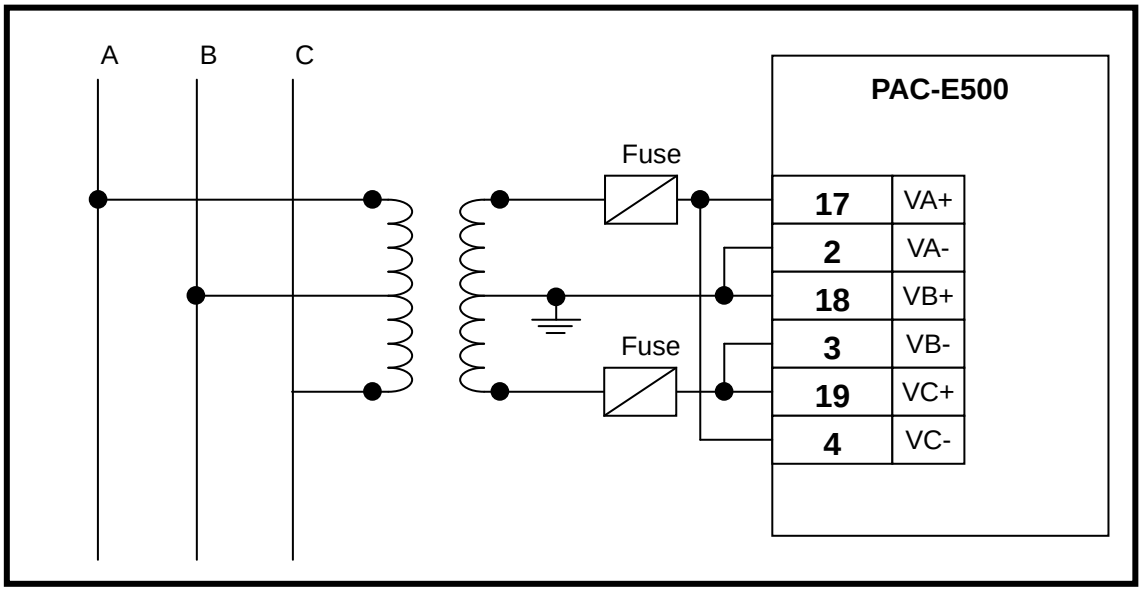
Refer to the Table 5.2. Terminal Block Diagram Table in the above



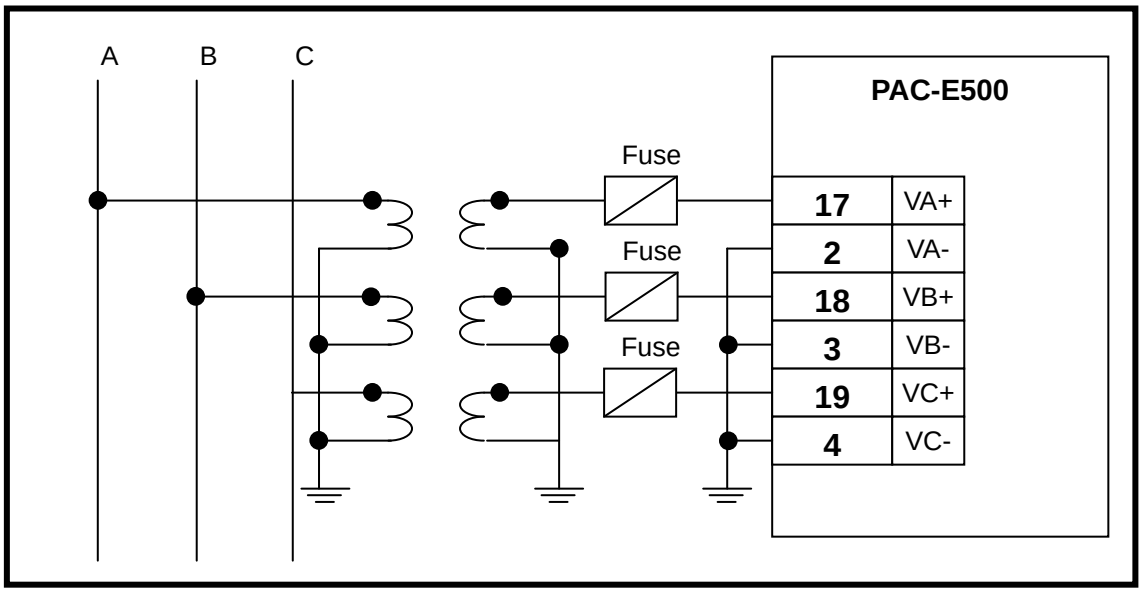
<Figure 5.3.2. CT Connections>

5.2.3 PT Connections

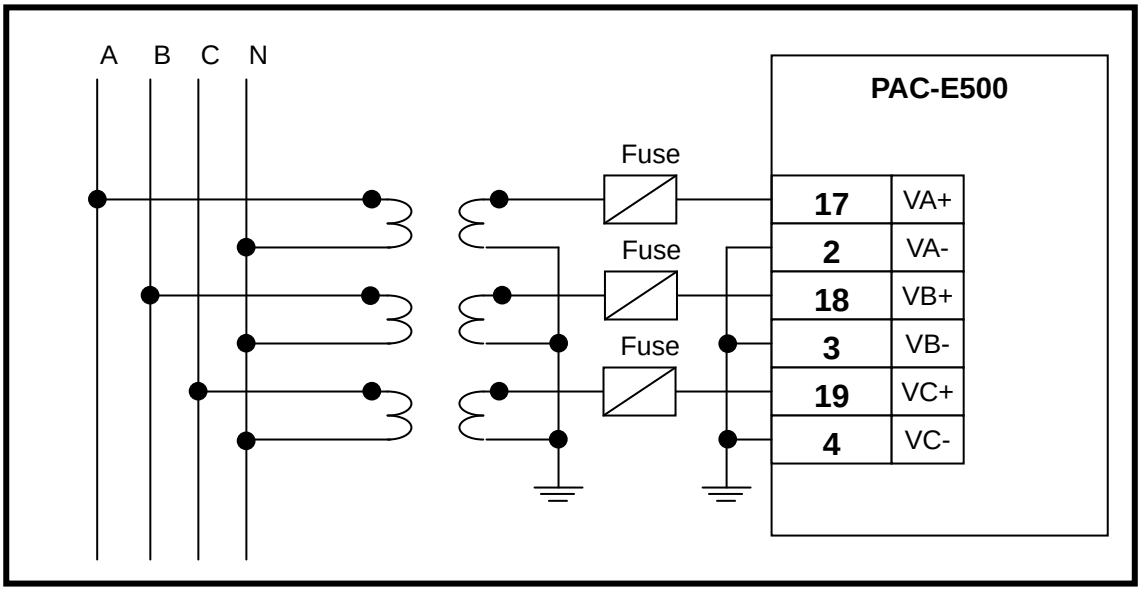
Refer to the Table 5.2. Terminal Block Diagram Table in the above.



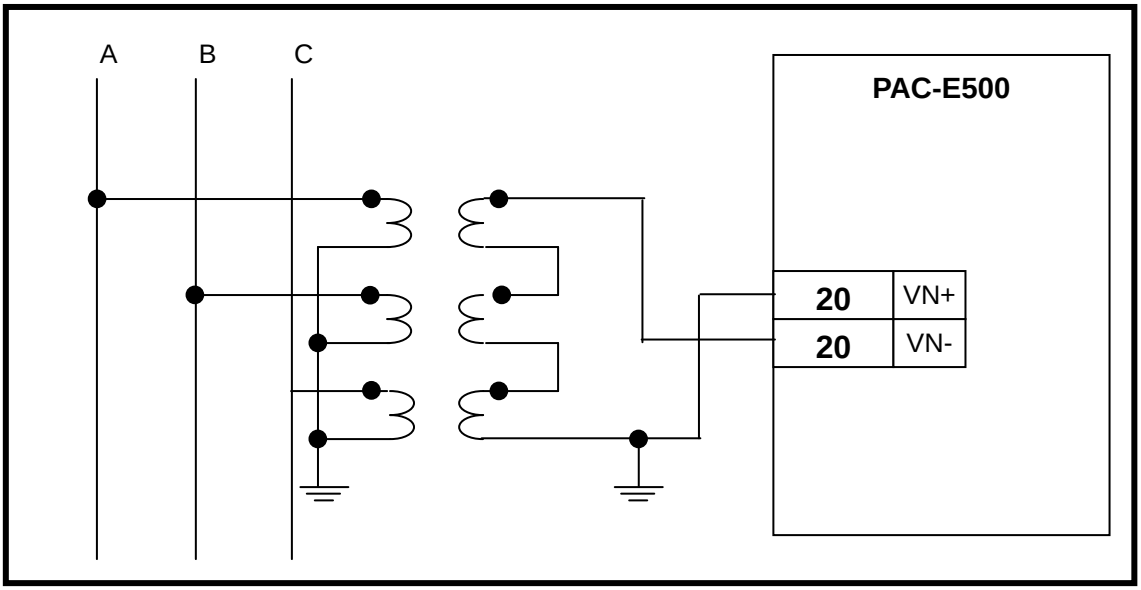
<Figure 5.3.3.1. V-Connections PT Connections – ABC Rotation>



<Figure 5.3.3.2. Normal PT Connections>



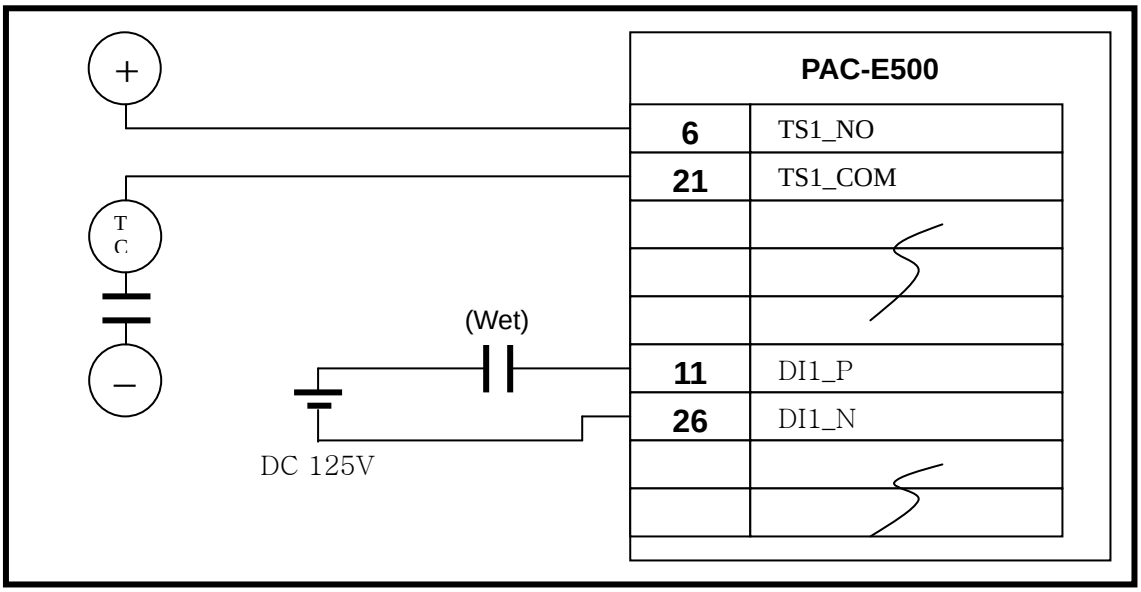
<Figure 5.3.3.3. 3P4L PT Connections>



<Figure 5.3.3.4. GPT Connections>

5.2.4 Input/Output Contacts Connection

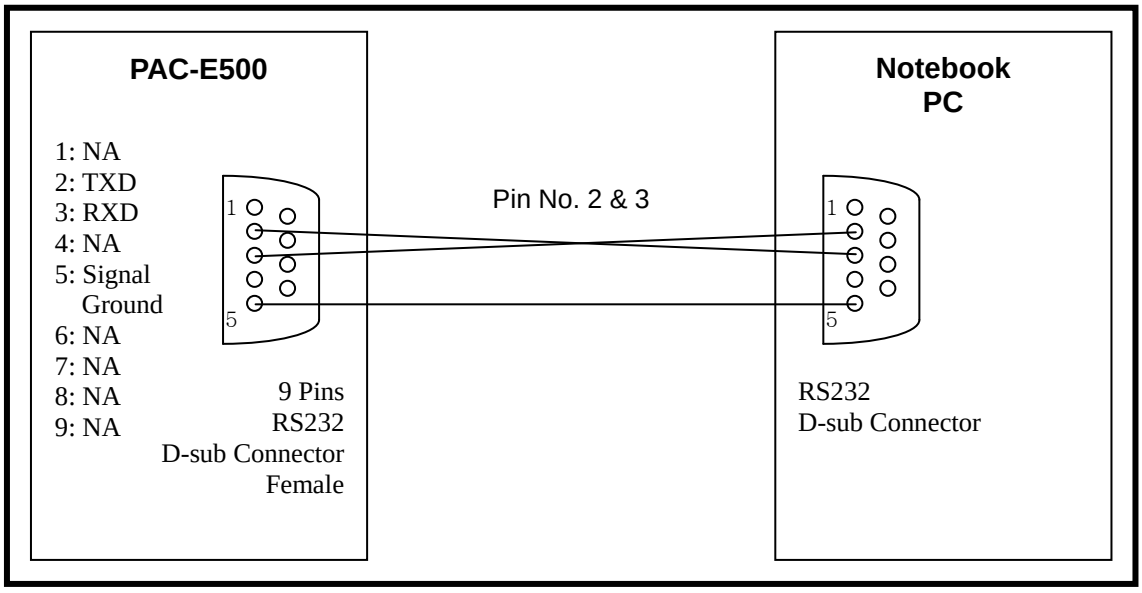
Refer to the Table 5.2. Terminal Block Diagram Table in the above.



<Figure 5.3.4 DI & DO Connection of PAC-E500>

5.2.5 RS232 Port Connection

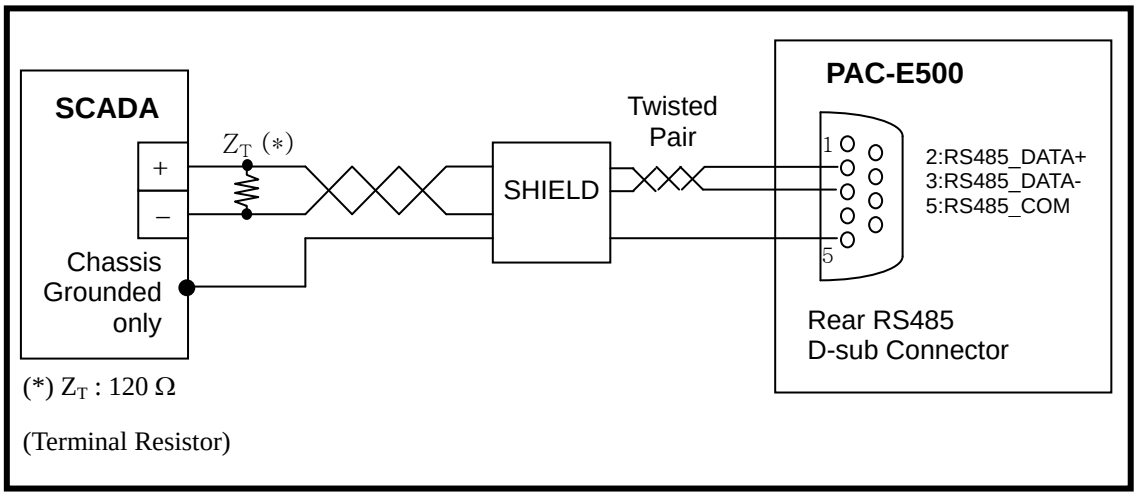
Refer to the Table 5.2. Terminal Block Diagram Table in the above.



<Figure 5.3.5 RS232 Port Connection of PAC-E500>

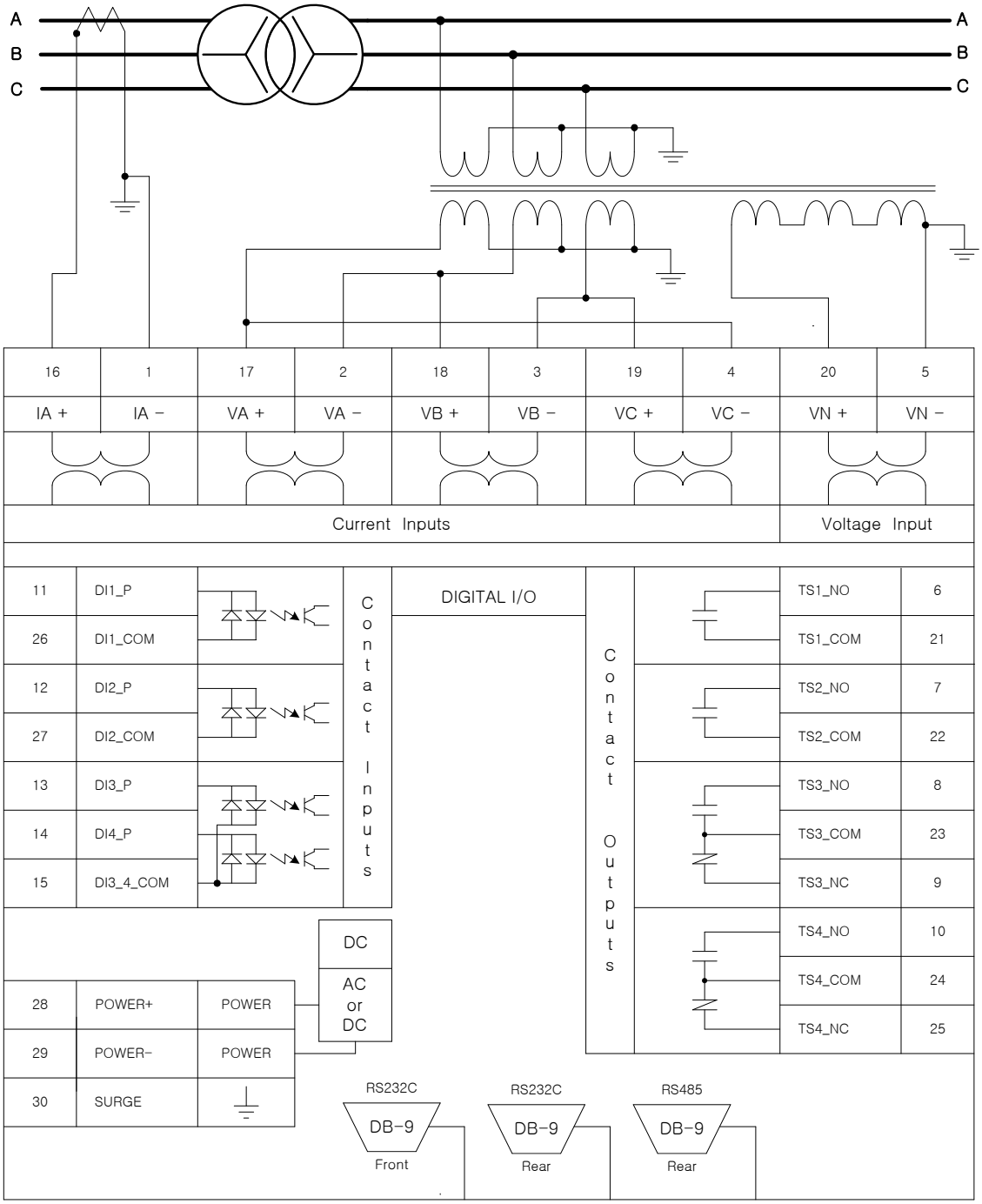
5.2.6 RS485 Port Connection

Refer to the Table 5.2. Terminal Block Diagram Table in the above.



<Figure 5.3.6 RS485 Port Connection of PAC-E500>

5.2.7 Wiring Diagram



<Figure 5.3.7 Wiring Diagram>

6 Setting & Configuration Software

Operate status, setting and metering information are shown and changed through Setting software of PAC-E500.

6.1 SETTING SOFTWARE

Modification of settings or/and system configuration is generally performed using keypad buttons in the LCD menu on front panel of PAC-E500. But this job is handled item by item at one time. So, this setting tool is used to facilitate a batch job. Refer to the figure of RS232 connection in the previous section, and the ModBus protocol is used. All the data can be saved in files as project concept and the specific setting values are downloaded to PAC-E500 just by opening the saved project data file. Other functions include event data uploading & listing, fault data uploading, and data printing.

Caution **: Certainly, COMport must be used 1 port of front or rear because RS232C port located front and rear panel of PAC-E500 is not communicate at the same time.**

6.1.1 Program Menu

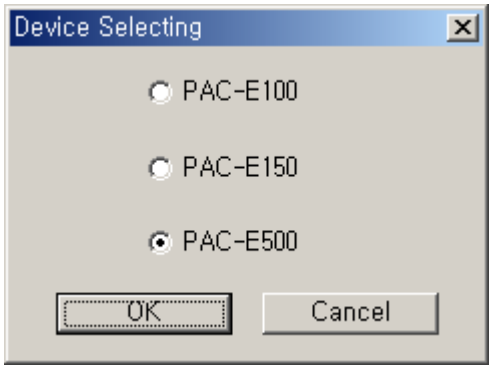
Setting software menu is composed of port setting, file input/output and setting of relay, and each menu is described below.

▪Program Menu	
Device Selecting	Selected 3 kind of PAC-E Series (3 type)
Open	Saved Project File Loading
Save	Edited Data Saving to File
Report	Edited Data Saving to Text File and Printing
COM	Communication Port Selection on PC. (Addr: 1 fixed)
Connect	RS232 Port Communication Connection and Initialization
Disconnect	Communication Disconnection and Port Closing
Upload	Set Data on PAC-E500 Transfer from PAC-E500 to PC
Download	Edited Data on the program Transfer from PC to PAC-E500.
Setting	Open setting page of System, Protection, Contact In/Out, LED
Monitor	Open indicating page of Measuring value, status of self-diagnosis, Contact input/output and LED output.
About	Version Information of Setting Software
New	New Project Generation for Setting
Close	Finished Project Generation for Setting
Save As	Edited Data Saving to File as Different Name
Exit	Program Exit

<Table 6.1.1. Program Menu>

6.1.2 Device Selecting

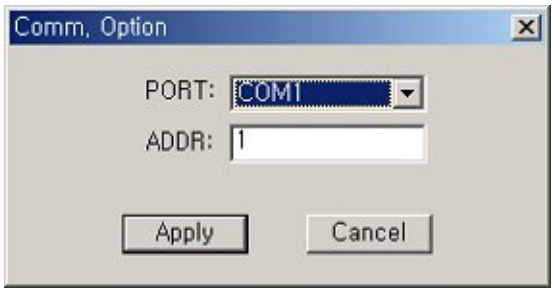
It must be selected to control relay model because setting software is program that control 3 types relay by 1 program. Press "Device Selecting" ( ) button, show window as below figure and select to control relay model.



<Figure 6.1.2. Device Selecting>

6.1.3 Communication Port Setting

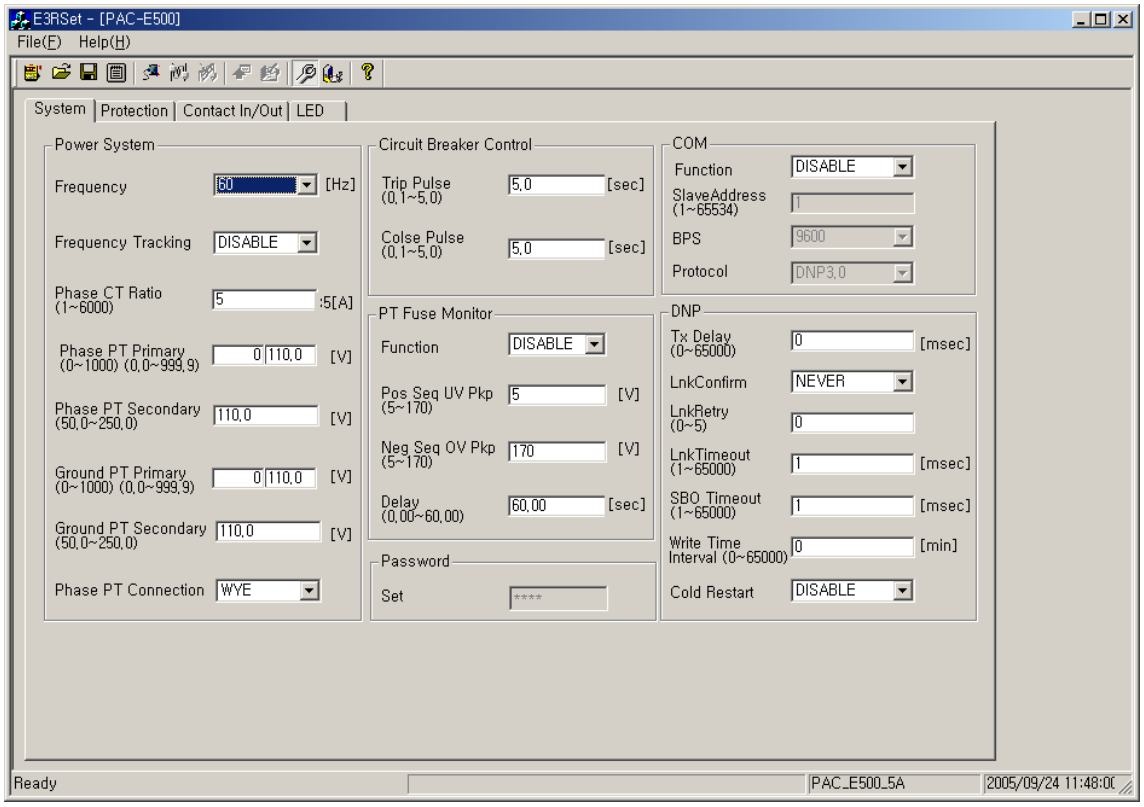
It can use to select 1 of 15 ports and another COMport when it can't use COMport due to other equipment. Address is fixed 1 when communicate through RS232C port. It must be set Address as COM Address of PAC-E500 when communicate through RS485 port.



<Figure 6.1.3. Port setting>

6.1.4 System Configuration

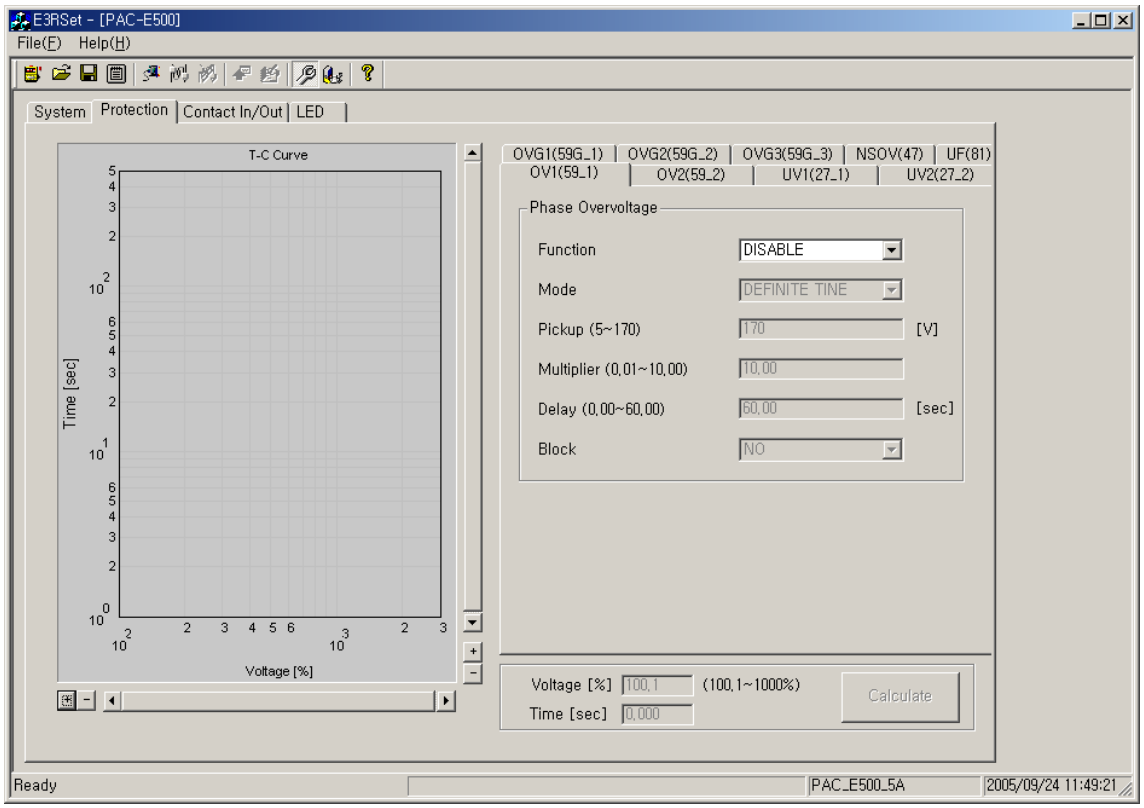
This configuration is related to general system setting of PAC-E500. Setting items are Power System, Circuit Breaker Control, Password, COM, and DNP communication. Each item's function is the same as that of LCD menu on front panel, and refer to chapter 4 Operational Description for more detailed explanation.



<Figure 6.1.4. Setting Tool-System Configuration>

6.1.5 Protection Setting

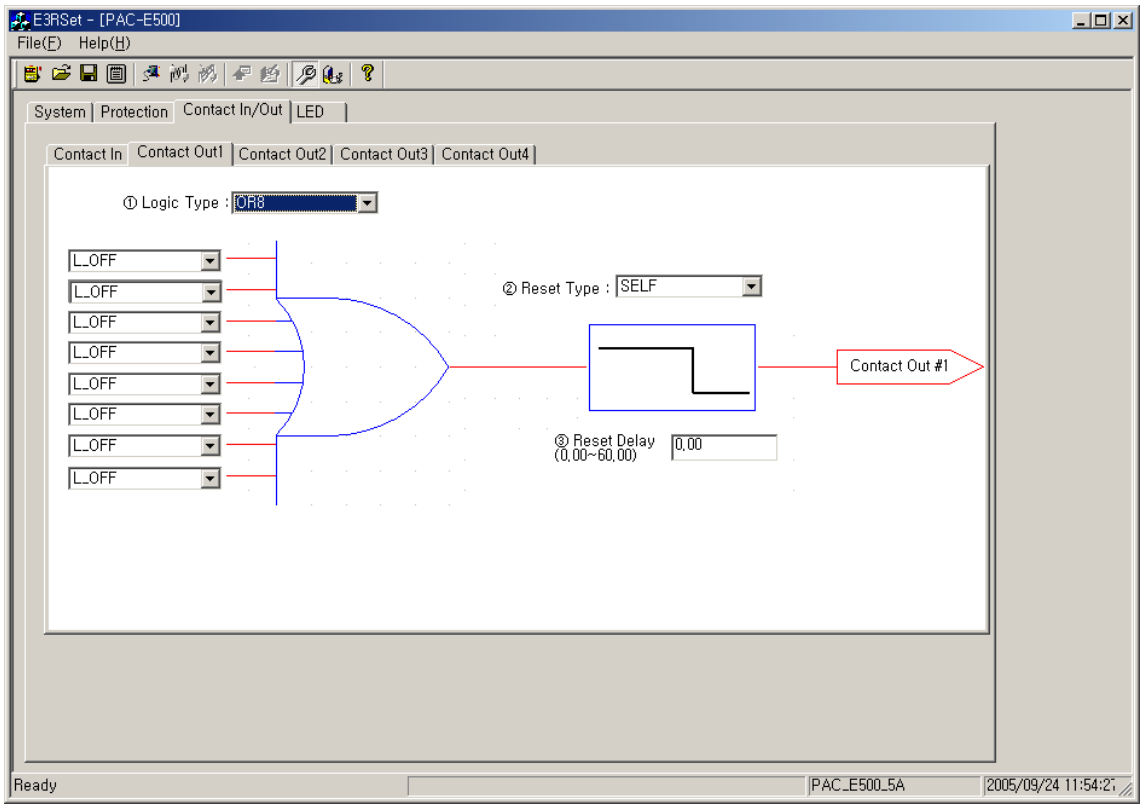
This setting is a main settings modification of PAC-E500 and is related to the setting items of protection elements. In the sub-frames, it is separated into OVR (OV1, OV2), UVR (UV1, UV2), OVGR (OVG1, OVG2, OVG3), NSOV (47) and UF (81). The selected TC curve represents each inverse time element and reflects the change of time dial multiplier. Refer to LCD setting menu on chapter 4 Operational Description for more detailed explanation.



<Figure 6.1.5. Setting Tool-Protection >

6.1.6 Contact In/Out Setting

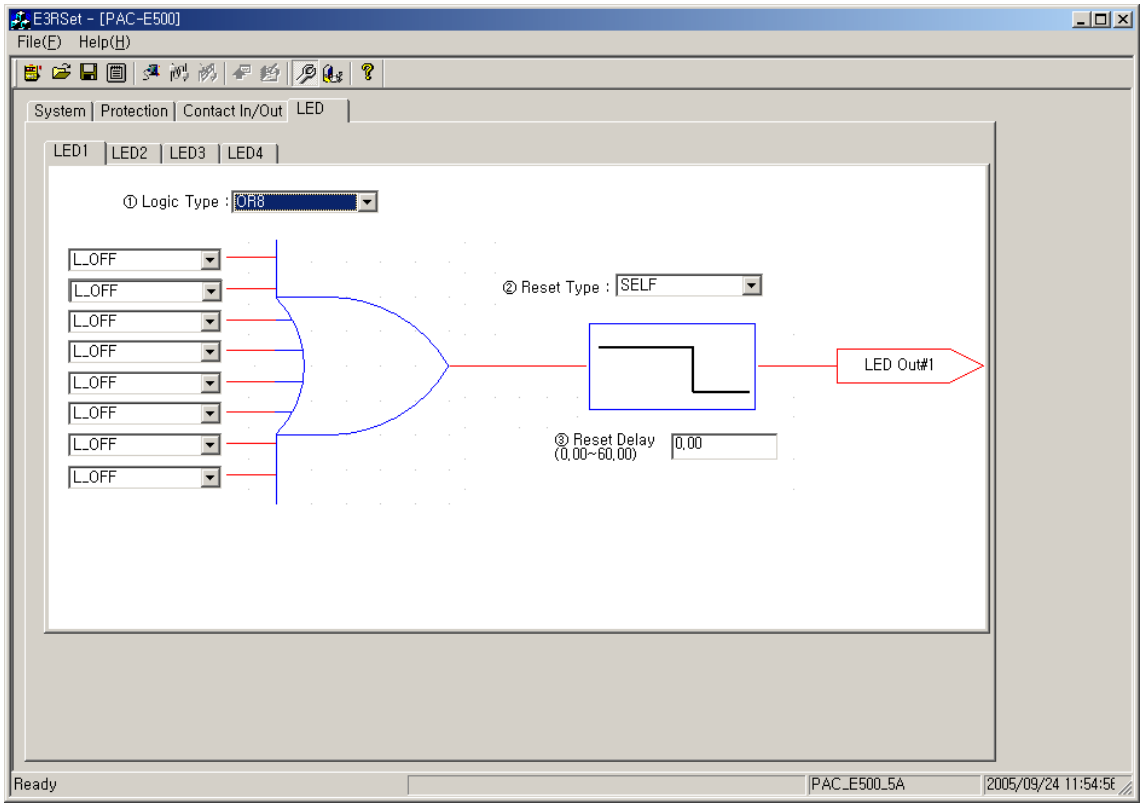
This setting is set up contact input/output of PAC-E500. Setting items are 4 Contact Input and 4 Contact Output. Refer to LCD setting menu on chapter 4 Operational Description for more detailed explanation.



<Figure 6.1.6. Setting Tool-Contact Input/Output>

6.1.7 LED Setting

This setting is each of Programmable LED respectively. Refer to LCD setting menu on chapter 4 Operational Description for more detailed explanation.

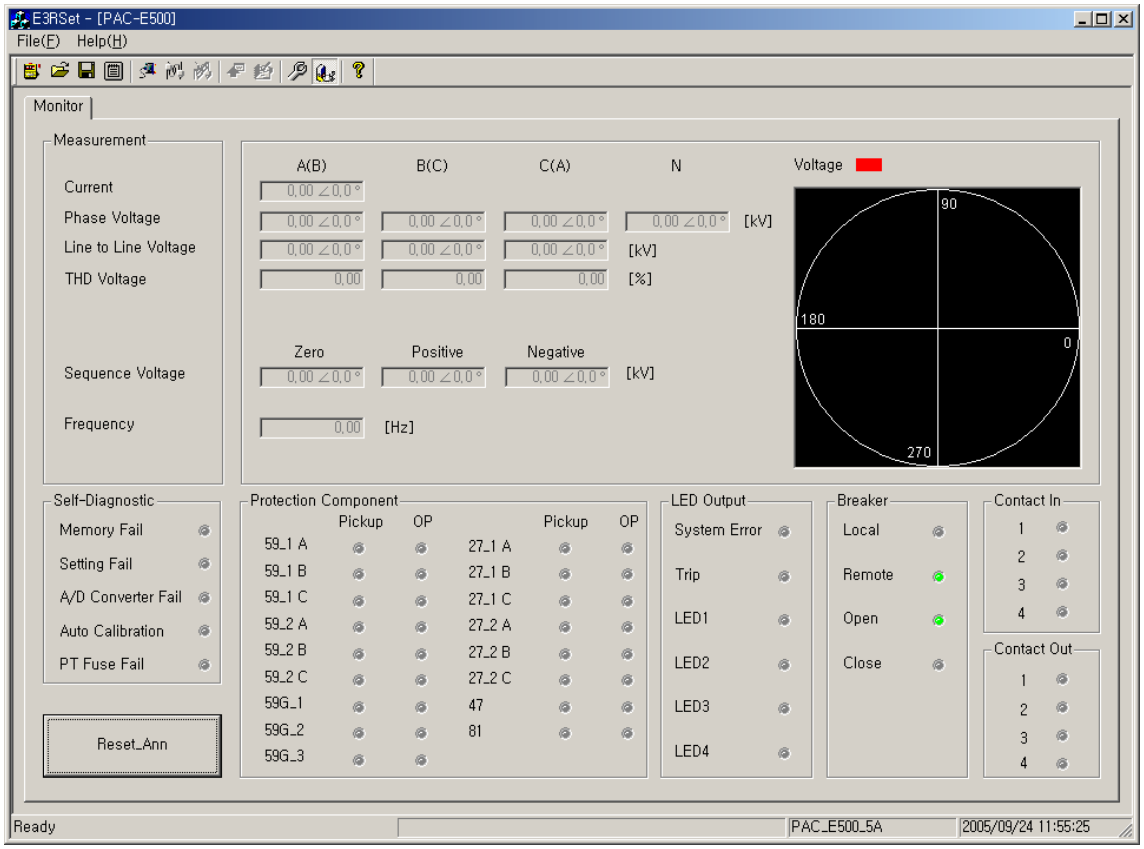


<Figure 6.1.7. Setting Tool-Programmable LED>

6.1.8 Monitor

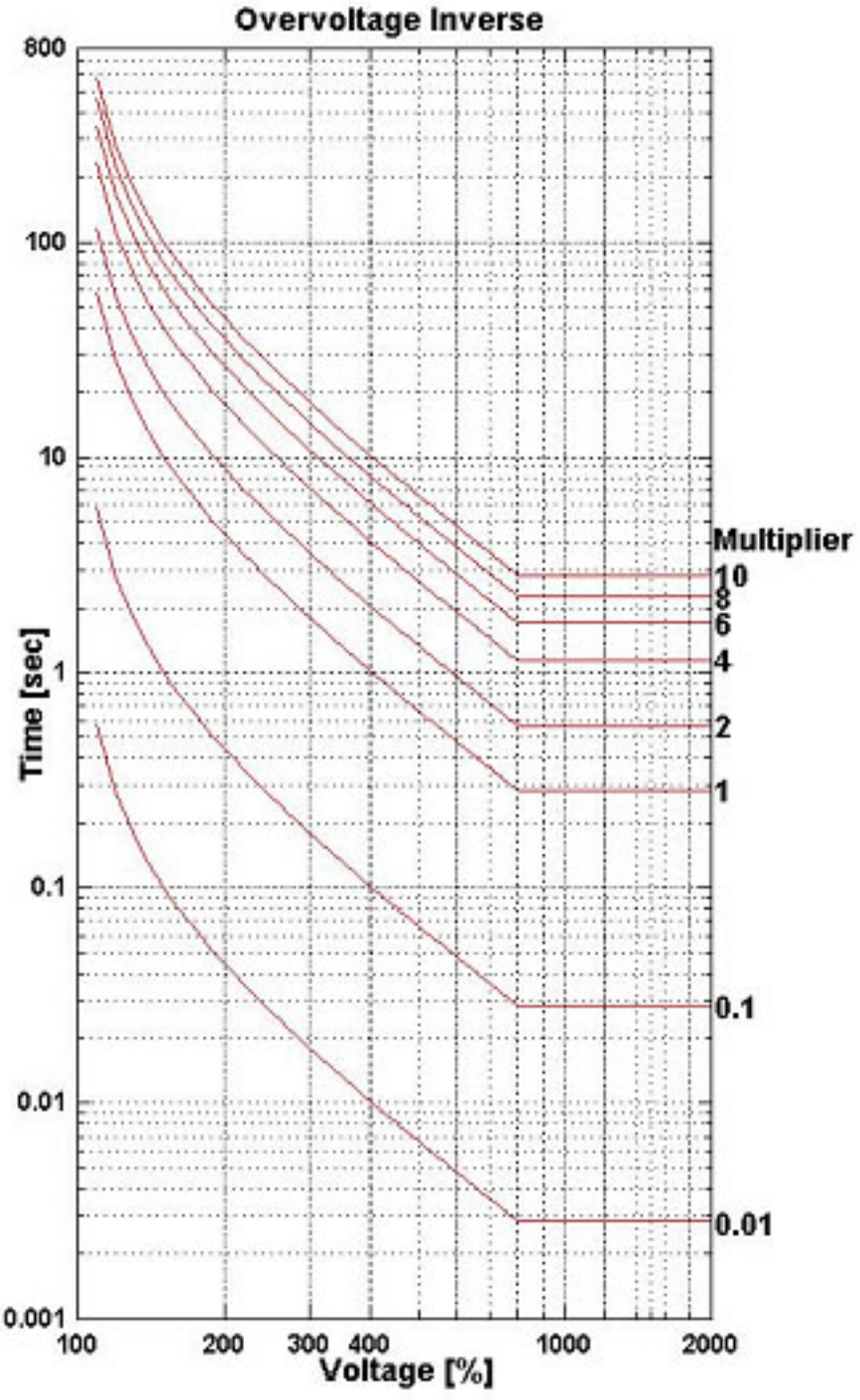
Monitor display shows status monitoring of PAC-E500. Elements or status monitoring is composed of Measurement, Self Diagnosis, Protection Component, LED Output, Breaker and Contact Input/ Output, and there is "Annun Reset" button on front panel's left.

Refer to LCD setting menu on chapter 4 Operational Description for more detailed explanation.

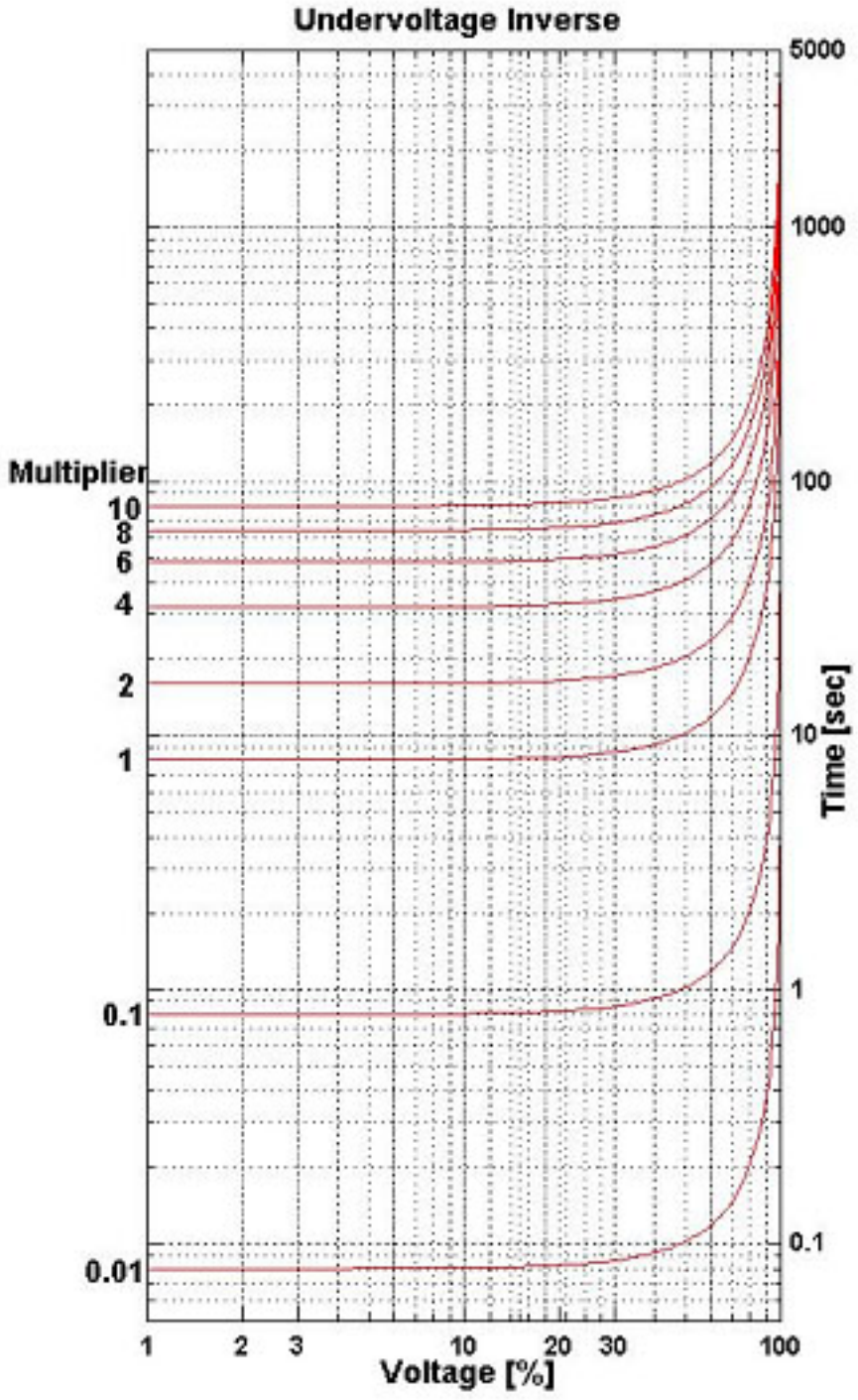


<Figure 6.1.8. Setting Tool-Monitoring>

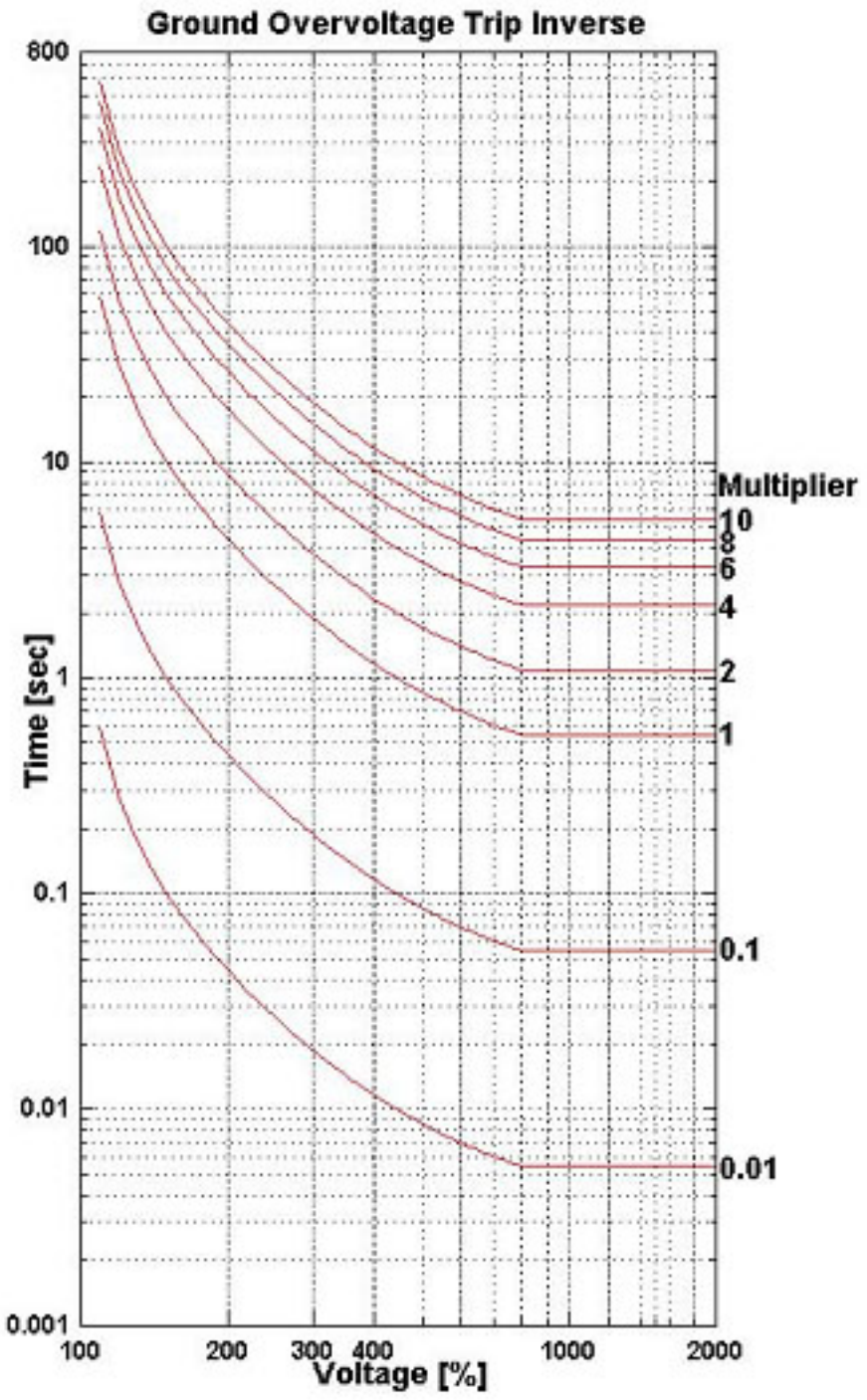
Appendix A. TC Characteristics Curves



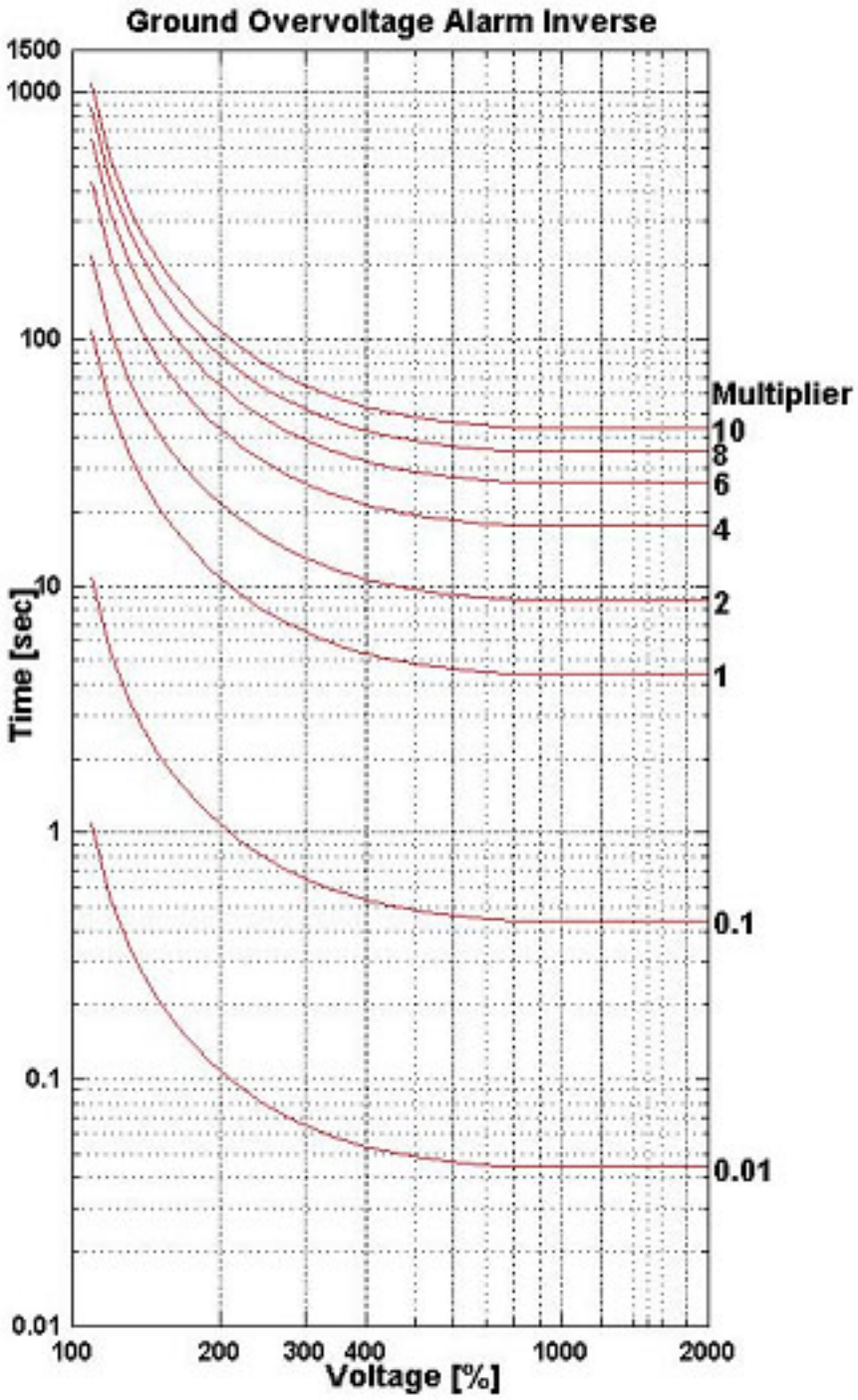
<Figure A.1 Over Voltage Curve>



<Figure A.2 Under Voltage Curve>

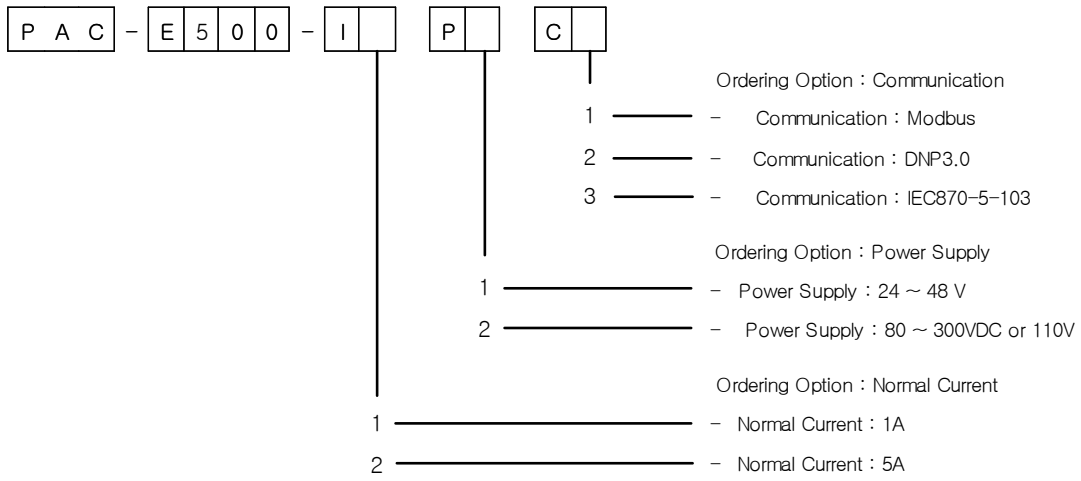


<Figure A.3 Ground Over Voltage TRIP Curve>



<Figure A.4 Ground Over Voltage Alarm Curve>

Appendix B. Ordering Option


P A C - E 5 0 0 - I P C
Ordering Option : Communication
1 - Communication : Modbus
2 - Communication : DNP3.0
3 - Communication : IEC870-5-103
Ordering Option : Power Supply
1 - Power Supply : 24 ~ 48 V
2 - Power Supply : 80 ~ 300VDC or 110V
Ordering Option : Normal Current
1 - Normal Current : 1A
2 - Normal Current : 5A

P&C Technologies Co., Ltd.

Head of Office & Factory

Address #898-43, Hogye-Dong, Dongahn-Gu, Anyang, Gyonggi-Do, 431-080, Korea
Tel 82 31 4525791
Fax 82 31 4525793

Seoul Office

Address 5F, Kwangmyung B/D, #115-3, Bangi-dong, Songpa-gu, Seoul, 138-050 Korea
Tel 82 2 22408106
Fax 82 2 22408188
Homepage http://www.pnctech.co.kr/